HARGIS + ASSOCIATES, INC.

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APPENDIX C

FIELD SAMPLING PLAN

APPENDIX C

FIELD SAMPLING PLAN

PRE-DESIGN INVESTIGATION

NORTHERN EXTRACTION AND CENTRAL EXTRACTION AREAS

OPERABLE UNIT 2

OMEGA CHEMICAL CORPORATION SUPERFUND SITE

LOS ANGELES COUNTY, CALIFORNIA

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LIST OF ACRONYMS/ABBREVIATIONS/COMMON TERMS

2010 FS	August 2010 OU2 Feasibility Study
2010 RI	August 2010 OU2 Remedial Investigation
2011 ROD	OU2 Interim Action Record of Decision, dated September 20, 2011
2016 CD	Consent Decree lodged April 20, 2016 covering Operable Unit 2 at the Omega Chemical Corporation Superfund Site
AOP	Advanced oxidation process
bgs	Below ground surface
CDM Smith	CDM Smith, Inc.
CDWR	California Department of Water Resources
CE Area	Central extraction area (The location of the CE area is depicted in the 2016 CD, Appendix C as the area between the NE and Telegraph Road.)
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COCs	Chemicals of Concern
COPCs	Chemicals of Potential Concern
Day	Day means a calendar day unless expressly stated to be a working day. A working day is a day other than a Saturday, Sunday or federal or state holiday.
DO	Dissolved oxygen
DQOs	Data Quality Objectives
DTSC	California Department of Toxic Substances Control
EC	Electrical conductivity
ELAP	Environmental Laboratory Association Program
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Differences
FSP	Field Sampling Plan
Geosyntec	Geosyntec Consultants
gpm	Gallons per minute

LIST OF ACRONYMS/ABBREVIATIONS/COMMON TERMS (continued)

H+A	Hargis + Associates, Inc.
HASP	Health and Safety Plan
HHRA	Human Health Risk Assessment
ICIAP	Institutional Controls Implementation and Assurance Plan
ICs	Institutional Controls. (ICs are non-engineering controls that will supplement engineering controls to prevent or limit potential exposure to hazardous substances, pollutants, or contaminants at the Site related to the Work and to ensure that the portion of the ROD applicable to the Work is effective.)
IDW	Investigation-derived wastes
IX	Ion exchange
Key Treatment Constituents	Treatment constituents that may require treatment to meet discharge requirements associated with end-use (reinjection, spreading basin, reclaim). The Key Treatment Constituents are considered during the RD based on end use.
LE Area	Leading Edge Area of OU2 is the area in the 2016 CD, Appendix C that is south of the CE Area
Main COCs	13 COCs identified in the ROD as "main COCs" and listed in Table C-1. Includes eleven VOCs, 1,4-dioxane, and hexavalent chromium. The Main COCs are included in the COC list for the RD.
MCLs	Maximum Contaminant Levels (EPA and California)
MS	Matrix Spike
MSD	Matrix Spike Duplicate
msl	Mean sea level
NE Area	Northern extraction area (The location of the NE area is depicted in Appendix C of the 2016 CD as an area north of the CE)

LIST OF ACRONYMS/ABBREVIATIONS/COMMON TERMS (continued)

NE/CE Area	A portion of the area of the groundwater contamination identified by EPA as OU2 in its 2011 ROD. The NE/CE Area is bounded by the OU2 boundary as depicted in the 2016 CD, Appendix C and the area north of Telegraph Road. It includes the NE and CE areas as depicted in the ROD as well as the northern portion of the LE area as depicted in the ROD.
NF	Nanofiltration
NL	Notification Level, California State Water Resources Control Board
O&M	Operations and Maintenance
OFRP	Oil Field Reclamation Project
Omega Property	The property formally owned by the Omega Chemical Corporation, encompassing approximately one acre, located at 12504 and 12512 East Whittier Blvd, Whittier, California. OU1 and OU3 are addressing soil, groundwater, and soil vapor source control at the Omega Property.
ORP	Oxidation-reduction potential
OU	Operable Unit, a discrete action that comprises an incremental step in the remediation of a contaminated site.
OU2	Operable Unit 2, the contamination in groundwater generally downgradient of Omega Property, much of which has commingled with chemicals released at other locations into a regional plume containing multiple contaminants which, when considered in total, is more than four miles long and one mile wide. The OU2 boundary is depicted in the 2016 CD, Appendix C.
PC	Project Coordinator, an individual who represents the SWDs and is responsible for overall coordination of the Work.
PDI	Pre-Design Investigation
PDIWP	Pre-Design Investigation Work Plan
Performance Standards	The cleanup levels and other measures of achievement of the remedial action objectives, as set forth in the SOW, Paragraph 1.3(c).
PRPs	Potentially Responsible Parties
PVC	Polyvinyl chloride

LIST OF ACRONYMS/ABBREVIATIONS/COMMON TERMS (continued)

QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RA	Remedial Action (Remedial Action shall mean all activities Settling Defendants are required to perform under the 2016 CD to implement the 2011 ROD, in accordance with the SOW, the final approved RD submission, the approved RA Work Plan and other plans approved by EPA, including the ICIAP, until the Performance Standards are met, and excluding performance of the RD, O&M, and the activities required under the Retention of Records section of the 2016 CD.)
RAOs	Remedial Action Objectives
RAWP	Remedial Action Work Plan
RD	Remedial Design (Remedial Design means those activities to be undertaken by Settling Work Defendants to develop the final plans and specifications for the Remedial Action pursuant to the Remedial Design Work Plan.)
RDWA	Remedial Design Work Area. (The RDWA consists of the NE/CE Area and includes potential treated water end use locations that may be adjacent to or outside of OU2.)
RDWP	Remedial Design Work Plan
RO	Reverse osmosis
RWQCB-LA	Regional Water Quality Control Board, Los Angeles Region
Site	Omega Chemical Corporation Superfund Site, originally listed on the National Priorities List on January 19, 1999, which is located in Los Angeles County, California, and includes the contamination being addressed by multiple Operable Units.
SOPs	Standard Operating Procedures
SOW	Statement of Work, Appendix B to the 2016 CD.
Supervising Contractor	The entity selected by SWDs to oversee field work.
SVOCs	Semivolatile organic compounds

LIST OF ACRONYMS/ABBREVIATIONS/COMMON TERMS (continued)

SWDs	Settling Work Defendants, as identified in Appendix E to the 2016 CD. SWDs include the McKesson Corporation and OPOG (Omega Chemical Corporation Superfund Site Potentially Responsible Party Organized Group).
SWRCB	State Water Resources Control Board
TDS	Total dissolved solids
UGSG	United States Geological Survey
VOCs	Volatile organic compounds
WAMP	Work Area Monitoring Plan
Waste Material	Shall mean (1) any "hazardous substance" under Section 101(14) of CERCLA, 42 U.S.C. § 9601(14); (2) any pollutant or contaminant under Section 101(33), 42 U.S.C. § 9601(33); (3) any "solid waste" under Section 1004(27) of RCRA, 42 U.S.C. § 6903(27); or as any of the foregoing terms are defined under any appropriate or applicable provisions of California law.
Work	All activities and obligations the SWDs are required to perform under the 2016 CD, except the activities required under the Retention of Records section of the 2016 CD.
Work Area	The portions of OU2 that are the subject of Work under the 2016 CD and the SOW.
WRD	Water Replenishment District of Southern California

LIST OF ADDITIONAL ACRONYMS AND ABBREVIATIONS

1,1-DCA	1,1-Dichloroethane
1,1-DCE	1,1-Dichloroethene
1,1,2-TCA	1,1,2-Trichloroethane
1,2-DCA	1,2-Dichloroethane
1,2,3-TCP	1,2,3-Trichloropropane
cis-1,2-DCE	cis-1,2-Dichloroethane
Freon 11	Trichlorofluoromethane

LIST OF ADDITIONAL ACRONYMS AND ABBREVIATIONS (continued)

Freon 113	1,1,2-Trichloro-1,2,2-trifluorethane
NDMA	N-Nitrosodimethylamine
PCE	Tetrachloroethene, perchloroethene
TCE	Trichloroethene

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PRE-DESIGN INVESTIGATION

NORTHERN EXTRACTION AND CENTRAL EXTRACTION AREAS

OPERABLE UNIT 2

OMEGA CHEMICAL CORPORATION SUPERFUND SITE

LOS ANGELES COUNTY, CALIFORNIA

1. INTRODUCTION

This Field Sampling Plan (FSP) has been prepared by Hargis + Associates, Inc. (H+A) on behalf of the Settling Work Defendants (SWDs) to document field sampling activities associated with the Pre-Design Investigation (PDI) to support remedial design (RD)of the Northern Extraction/Central Extraction (NE/CE) Area for the Omega Chemical Corporation Superfund Site (Site). This FSP has been prepared in accordance with the Statement of Work (SOW), Appendix B of the Consent Decree (2016 CD) for Operable Unit 2 (OU2) at the Site (United States Environmental Protection District [EPA], 2016) (Figures C-1 and C-2).

OU2 of the Site addresses contamination in groundwater generally downgradient of the Omega Property, much of which has commingled with chemicals released at other locations into a regional plume containing multiple contaminants which, when considered in total, is more than four miles long and one mile wide. The Work covered by the SOW includes groundwater containment in the NE/CE Area. The Remedial Design Work Area (RDWA) is a portion of OU2. It includes the NE/CE Area plus any potential locations outside this area that could be used for water end use management (Figure C-2).

1.1 Objectives

The SOW for the PDI Work Plan (PDIWP) requires an evaluation and summary of existing data relevant to the following:

- Definition of the areas and depths targeted for hydraulic control in the Northern Extraction (NE) and Central Extraction (CE) Areas;

- Estimation of hydraulic conductivity in the NE/CE Area capture zone;
- Selection of groundwater extraction rates and locations for design of the remedy; and
- Addressing any concerns about the quantity, quality, completeness, or usability of water quality or other data upon which the design will be based

The purpose of the PDI field sampling tasks is to address critical data gaps to support RD by conducting additional field investigations. The data gaps analysis presented in Appendix A to the PDIWP focuses on the following broad design considerations: extraction wellfield (depth and area requiring containment; quantity and quality of extracted water); treatment system (capacity and treatment requirements for each end use); and treated groundwater end use design, for which field data collection has been prioritized to support reinjection (quantity and quality requirements for reinjection), as the data to support design of other options for treated groundwater end uses will be obtained from the owners/operators of nearby spreading basins and reclaimed water distribution systems.

The PDI field investigation work is intended to provide data to support the RD of the CE/NE Area Remedial Action (RA). Data Quality Objectives (DQOs) are presented in Appendix B to the PDIWP and have been incorporated into the Quality Assurance Project Plan (QAPP) for the investigations being conducted to fulfill the requirements of the 2016 CD SOW.

1.2 Project Organization, Roles and Responsibilities

The following sections cover the general areas of project management, project organization, and responsibilities of the project participants.

1.2.1 EPA Project Manager

The EPA Project Manager bears overall responsibility for the direction of the scope of work to be performed for the project. The EPA Project Manager will provide final review and approval of the PDIWP, the PDI FSP and supporting standard operating procedures (SOPs) and supporting QAPP, as well as, the reports generated upon conclusion of field work. The EPA Project Manager will provide coordination of the overall project and will provide overview and direction to EPA's contractors.

1.2.2 EPA Project Quality Assurance Officer

The EPA Project Quality Assurance (QA) Officer will review QA documents, including the QAPP which supports the PDIWP. The EPA Project QA Officer will provide comments and recommendations to the EPA Project Manager regarding appropriate methodologies, reporting limits, sampling, and preservation techniques, DQOs, and other chemistry-related issues. The EPA Project QA Officer will perform data validation tasks or will assign and supervise EPA data validation tasks as requested by the EPA Project Manager.

1.2.3 SWDs' Project Coordinator

The SWDs' Project Coordinator is the individual who represents the SWDs and is responsible for the overall coordination of the Work. In accordance with the 2016 CD, this SWD Project Coordinator must have sufficient technical expertise to conduct the Work and may not be an attorney representing any SWDs in this matter and may not act as the Supervising Contractor. SWDs' Project Coordinator may assign other representatives, including other contractors, to assist in coordinating the Work. It is anticipated that Jack Keener of de maximis, inc. will be the SWD's Project Coordinator.

1.2.4 Pre-Design Investigation Implementation Team

The PDI tasks will be conducted by qualified contractors that will be responsible for implementing respective tasks in accordance with the PDIWP and this FSP as approved by EPA. The PDI Evaluation Report will be prepared by a qualified contractor that will be responsible for evaluating existing and PDI data to meet the requirements outlined in the SOW. The contractor responsible for preparing the PDI Evaluation Report may rely on documents prepared by field implementation contractor(s) and/or other qualified contractors.

1.2.5 PDI Project Manager

The PDI Project Manager will be responsible for ensuring that each individual component of the PDI field tasks meets overall project objectives and will report to the SWDs' Project Coordinator. The PDI Project Manager must be experienced in environmental activities outlined in this FSP. Specific professional registrations are not required for the PDI Project Manager; however, if the PDI Project Manager serves as the Supervising Professional Geologist, the PDI Project Manager will be a Professional Geologist registered in California. The PDI Project Manager, to be assigned prior to scheduled activities, will:

- Assemble a project team who have the necessary experience/training, requirements/certifications and technical skills to successfully execute the work conducted in this FSP;

- Ensure that the procedures specified in this FSP are implemented and that field activities conducted in the RDWA meet stated objectives;
- Determine sampling and analytical strategies with the assistance of the QA team;
- Approve, designate, and monitor corrective action for field and office activities, as needed; and
- Review and approve project documents, data assessment results, and database summary reports.

1.2.6 Project Quality Assurance Manager

The Project QA Manager is responsible for informing field personnel of the Quality Control (QC) practices to be employed prior to field work; performing and overseeing QA/QC functions throughout implementation activities; and communicating QA/QC status and requirements to the SWDs' Project Coordinator and PDI Project Manager. The Project QA Manager will:

- Report directly to the SWDs' Project Coordinator;
- Coordinate QA/QC functions with the PDI Project Manager;
- Review and approve QA/QC documents pertaining to PDI field activities;
- Review sampling memos and check them against FSP requirements and assign sample identifiers for associated QC samples, including trip blanks (if applicable), equipment blanks (when applicable), field blanks, field duplicates, split samples (if applicable), and performance check samples (if applicable);
- Coordinate field sampling efforts with the analytical laboratories;
- Prepare laboratory services agreement letters to ensure that QA objectives are met;
- Maintain a record of samples submitted for analysis to the laboratories, the analyses performed, and the final results;
- Ensure that proper sample custody procedures are followed;
- Review chain-of-custody records and sample transmittal documents for completeness;
- Ensure that appropriate field measurement data and analytical laboratory data are entered, stored, maintained, and backed-up in an electronic database management system;

- Oversee and coordinate the assessment and validation of the quality of data, and review analytical results with project personnel; and
- Perform or oversee field procedure audits and oversee laboratory system audits, if conducted.

1.2.7 Data Manager

The Data Manager is responsible for setup and maintenance of the electronic database and electronic data deliverables. The Data Manager will report to the PDI Project Manager and coordinate with the Laboratory Project Manager and Project QA Manager to ensure data is reported in the appropriate format. The Data Manager will also coordinate with the Data Validation Project Manager to ensure that the validation results are incorporated into the electronic database.

1.2.8 Health and Safety Coordinator

The Health and Safety Coordinator is responsible for assisting in implementing the applicable requirements of the Health and Safety Plan (HASP) with field tasks. The HASP will be signed by a certified industrial hygienist. The Health and Safety Coordinator reports directly to the PDI Project Manager.

1.2.9 Field Task Managers

The assigned Field Task Managers are responsible for overseeing field activities associated with specific tasks; for communicating field activities with the PDI Project Manager; and for coordinating sampling efforts with the QA Manager. The Field Task Manager must be experienced in the relevant environmental activities. Specific professional registrations are not required for Field Task Managers; however, if a Field Task Manager serves as the Supervising Professional Geologist, the Field Task Manager will be a Professional Geologist registered in California. The Field Task Managers will:

- Contact public entities and obtain permission to conduct respective field tasks in public rights-of-way;
- Coordinate field activities with subcontractors and ensure that contractual agreements are in place with the SWDs' Project Coordinator prior to implementing field work, as necessary;
- Coordinate sampling efforts with field personnel and the QA Manager;

- Prepare a memorandum before each field event that indicates the tasks to be conducted, including sampling location and methodology; number, type, and size of samples to be collected; and preservation and analytical methods required;
- Provide a sampling memorandum to the QA Manager for review against the respective Task of the PDI FSP and for assignment of sample identifiers for associated QC samples, including trip blanks (if applicable), equipment blanks (when applicable), field blanks, field duplicates, split samples (if applicable), and performance check samples (if applicable);
- Review the sampling memorandum with field personnel prior to sampling;
- Ensure that access requirements/permits are in place prior to implementing field activities;
- Ensure that field supplies and equipment, including sampling equipment, bottles, labels, custody seals, preservatives, and shipping supplies necessary to properly sample wells, are available and are in good working order; and
- Ensure that field personnel adhere to the procedures documented in this FSP and associated QAPP unless field conditions require project modifications.

1.2.10 Laboratory Project Manager

The Laboratory Project Manager ensures laboratory resources are available; reviews final analytical reports produced by the laboratory; reviews and approves the laboratory QA manual; coordinates scheduling of laboratory analyses; and supervises in-house chain-of-custody procedures. Analytical and physical laboratories specified for this project will be at a minimum, analytical laboratories certified by the California State Water Resources Control Board (SWRCB), Environmental Laboratory Accreditation Program (ELAP) to perform laboratory analyses for methods specified in this FSP and the associated QAPP. It is preferred that the laboratory currently participates in the EPA Performance Evaluation Test Program and provides proof of performance. A copy of certifications/licenses shall be submitted to the SWDs' Project Coordinator prior to implementing field work requiring laboratory analyses. Laboratory certifications shall be current and in place and shall use EPA- and/or SWRCB-approved methods.

1.2.11 Data Validation Project Manager

The Data Validation Project Manager specified for this project will have extensive experience in conducting data validation in accordance with EPA Contract Laboratory Program Functional Guidelines for Federal Superfund Sites (EPA, 2008 and 2010). The

Data Validation Project Manager ensures personnel resources are available; reviews final data validation reports produced by the data validation firm; ensures the laboratory QA manuals are reviewed; coordinates scheduling of laboratory audits with the QA Manager; and supervises in-house data validation procedures.

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2. BACKGROUND

The 2011 Record of Decision (ROD) identified 13 chemicals of concern (COCs) for OU2, eleven of which are VOCs (tetrachloroethene [PCE], trichloroethene [TCE], trichlorofluoromethane [Freon 11], 1,1,2-trichloro-1,2,2-trifluorethane [Freon 113], 1,1-dichloroethene [1,1-DCE],cis-1,2-dichloroethene [cis-1,2-DCE], chloroform, carbon tetrachloride, 1,1-dichloroethane [1,1-DCA], 1,2-dichloroethane [1,2-DCA], and 1,1,2-trichloroethane [1,1,2-TCA]); one is an inorganic constituent (hexavalent chromium) and the remaining compound is 1,4-dioxane (Table C-1). These 13 COCs will be referred to as Main COCs in the RD documents and are included in the COCs for the purpose of the RD. Containment of the Main COCs should also contain other chemicals, including benzene, toluene and other fuel related compounds, identified in the 2010 RI as chemicals exceeding screening levels.

The 2011 ROD also identified treatment standards for different end uses, which included ten of the 13 Main COCs and an additional eight or nine constituents, depending on end use. For the purposes of the PDI, the additional constituents will be referred to as “Key Treatment Constituents”. Based on the end use selected, extracted water will be treated for chemicals and constituents exceeding permit limits.

Additional background information pertaining to the work to be conducted as part of this FSP is presented in the PDIWP.

3. RATIONALE FOR SAMPLE LOCATIONS AND ANALYSES

The SWDs are conducting field investigations outlined in this FSP in the RDWA to provide data for design of the NE/CE Area RA. Data gaps were identified and DQOs were developed by addressing specific problem statements presented in Appendix A to the PDIWP. The SWDs have developed an optimized plan to collect and analyze PDI data in a time efficient manner. The plan incorporates concurrent implementation of selected tasks and also incorporates sequential data collection to minimize wasted or inefficient data collection efforts. There were six field tasks identified as part of the DQO process as follows (Figure C-3):

- Task 1: Access and Early Water Level Monitoring
- Task 2: Install and Sample NE/CE Area Exploratory Boreholes and Deep Monitor Wells
- Task 3: Install and Sample NE/CE Area Monitor Wells
- Task 4: Access / Install and Sample Monitor Wells in Primary Reinjection Area
- Task 5: Hydraulic Testing
- Task 6: PDI Groundwater Monitoring

The field data collected as part of the above tasks addresses the data needs identified to fulfill the requirements outlined in the SOW for the PDIWP (Table C-2). The rationale for data collection to be conducted as part of this FSP is described in the following sections:

- Groundwater Level Monitoring (Section 3.1);
- Groundwater Quality Sample Collection (Section 3.2);
- Aquifer Testing (Section 3.3);
- Lithologic Logging and Borehole Geophysical Logging (Section 3.4); and
- Investigation-Derived Wastes (Section 3.5).

3.1 Groundwater Level Monitoring

Groundwater level monitoring will be conducted at selected existing EPA and Water Replenishment District of Southern California (WRD) monitor wells and newly installed PDI monitor wells to:

- Determine similarities/differences in water level elevations and trends in existing EPA/WRD monitor wells in the RDWA and newly installed PDI monitor wells, to refine the understanding of hydrostratigraphic units near the NE/CE Area and within the RDWA;
- Determine direction of groundwater flow in different hydrostratigraphic units in the vicinity of the NE/CE Area to assist in locating extraction wells;
- Determine hydraulic gradients in the vicinity of the NE/CE Area to support development of estimated groundwater extraction rates; and
- Determine depth to groundwater and direction of groundwater flow in the vicinity of candidate reinjection areas.

3.1.1 Monitoring Methods

Water levels can be measured on a periodic basis using water level sounders (manual measurements), or they can be monitored on a nearly continuous basis using pressure transducers with built in data recorders (automated measurements). The pressure transducers allow for a robust analysis of water level trends in monitor wells over relatively short time frames, weeks to months.

Pressure transducers will be installed in each of the new PDI monitor wells after they have been constructed and will then be monitored for the duration of the PDI. There are at least 28 monitor wells planned as part of the PDI. The water level monitoring plan incorporates the use of these pressure transducers in 28 existing RDWA monitor wells early in the process until the respective pressure transducers are moved to a new PDI monitor well.

3.1.2 Monitoring Locations

Twenty-eight existing monitor wells at 11 locations have been selected for water level monitoring using pressure transducers. At most of these locations, monitor well clusters have been installed, providing data for multiple screened intervals. The list of existing wells where pressure transducers will be installed has been provided (Table C-3), and their locations are depicted on Figure C-4. Water level data will be collected from these wells over a period of several months, and will be used to refine the distribution and continuity of hydrostratigraphic units beneath the RDWA.

In accordance with the SOW in Appendix B to the CD, two areas of interest have been defined as potential groundwater extraction locations. The NE Area is located generally along Slauson Avenue west of Sorensen Avenue within the RDWA, and along Sorensen Avenue south of Slauson Avenue (Figure C-2). The CE Area is located generally along

Telegraph Road across the width of OU2 as depicted in the 2011 ROD (Figure C-2). Pressure transducers will be installed in the 11 PDI monitor wells to be constructed at three locations in the NE Area and 13 PDI monitor wells to be constructed at five locations in the CE Area (Table C-3; Figure C-5). Water level data will be used to determine the direction of groundwater flow and gradients in the NE/CE Area; and to refine the distribution and continuity of hydrostratigraphic units in the RDWA.

Pressure transducers will also be installed in PDI monitor wells to be installed in the primary candidate reinjection area (Table C-3; Figure C-5). Pressure transducers would also be installed in PDI monitor wells installed in contingency reinjection areas, if constructed. Water level data at these locations will be used to determine the depth to groundwater and the direction of groundwater flow in the candidate reinjection area(s) to support the evaluation of the reinjection end use of treated groundwater.

3.1.3 Monitoring Schedule

Pressure transducers will be installed in the existing 28 monitor wells within approximately 1 month of EPA's approval of the PDIWP and associated supporting documents. The pressure transducers will remain in the existing monitor well until the transducer is moved to a new PDI monitor well. The pressure transducers will remain in the PDI monitor wells until the last groundwater sample has been collected as part of PDI.

Manual water level measurements and transducer downloads, if applicable, will be conducted on a quarterly basis at existing and newly installed PDI monitor wells, from the time of installation of transducers in existing monitor wells until the final PDI groundwater sample is collected (Table C-3; Figure C-6).

3.2 Groundwater Quality Sample Collection

Groundwater sample collection will be conducted at selected existing EPA/WRD monitor wells and newly installed PDI monitor wells to:

- Define the areas and depths targeted for hydraulic control in the NE and CE Areas;
- Determine if reinjection is viable, and if so, define areas and depths of reinjection;
- Support evaluation of end use(s) of treated groundwater; and
- Design a treatment system.

3.2.1 Locations

Groundwater samples collected from PDI and existing EPA/WRD monitor wells in the NE/CE Area will refine the current understanding of lateral/vertical distribution of COCs in the respective areas to define the NE/CE Area target extraction area. In addition, groundwater samples will be collected from PDI monitor wells in candidate reinjection area(s) to refine the current understanding of water quality in the respective areas. The following summarizes the location for NE/CE Area and candidate reinjection areas.

3.2.1.1 NE/CE Area

In the NE Area, groundwater samples will be collected from 11 PDI monitor wells proposed at three locations and from 15 existing EPA monitor wells at four locations (Table C-4; Figure C-7). The existing and new PDI monitor wells provide data coverage across the width of OU2 in the NE Area. The PDI monitor wells in each cluster target aquifers at different depths at the respective location. The deepest PDI monitor wells in the two western clusters are targeting an aquifer (Lynwood) that is below existing EPA monitor well MW23D, which is the deepest monitor well in the area that contains COCs at concentrations exceeding MCLs or NLs. The deepest PDI monitor well in the eastern cluster targets a shallower aquifer (Jefferson) based on the results from nearby EPA cluster monitor well MW25. Given the good lateral coverage of existing and PDI monitor wells in this area, additional PDI monitor wells would only be constructed at one or more of the three PDI monitor well locations if groundwater from the deepest PDI monitor well in the respective location exceeded the MCL or NL (Table C-5).

In the CE Area, groundwater samples will be collected from 13 PDI monitor wells proposed at five locations and from 6 additional existing monitors at two locations (Table C-4; Figure C-7). The existing and new PDI monitor wells provide data coverage across OU2 in the vicinity of Telegraph Road. Twelve of the 13 PDI monitor wells are located in four well clusters. The PDI monitor wells in each of these four clusters target either sediments near the water table or deeper aquifers below the water table at the respective locations. The remaining PDI monitor well targets the sediments near the water table adjacent to existing WRD monitor well SFS_Hawkins cluster. The deepest PDI monitor wells in the four clusters are targeting an aquifer (Jefferson) which is deeper than the WRD monitor well (SFS_Hawkins_1c_5) that contained COCs at concentrations exceeding MCLs or NLs. Given the good lateral coverage of existing and PDI monitor wells in this area, additional PDI monitor wells would only be constructed at one or more of the four PDI monitor well locations if groundwater from the deepest PDI monitor well in the respective location exceeded the MCL or NL (Table C-5).

3.2.1.2 Candidate Reinjection Areas

In the primary candidate reinjection area, groundwater samples will be collected from four monitor wells proposed at four locations (Table C-4; Figure C-7). There are no existing EPA monitor wells in this area, as it is to the west of OU2. The monitor wells target the Gaspur aquifer which is shallow and is comprised of coarse sediments, making it a good candidate for shallow reinjection. The four monitor wells provide relatively broad coverage over the candidate reinjection area.

Groundwater samples may be collected in the contingency candidate reinjection area if the results of sampling and/or testing in the primary candidate area suggest reinjection is not viable in the area tested (Table C-4). The contingency area is also located to the west of OU2, but is in an area where the Gaspur aquifer is not likely present below the current water table, therefore the monitor wells target the next deeper aquifer (Gage). There are three contingency PDI monitor wells in this area, but there are no existing EPA monitor wells in this area (Table C-4; Figure C-7).

3.2.2 Laboratory Analyses

Groundwater samples collected from selected existing EPA/WRD monitor wells and the 24 new PDI monitor wells in the NE/CE Area will be used to assess target zones for extraction in the respective areas; and characterize influent water quality to the groundwater treatment system. Groundwater samples collected from the candidate reinjection area(s) will be used to characterize the background water quality in the respective area; and assess potential contribution from nearby source areas that have not been identified. The above information in conjunction with permit requirements for treated water end use would be used to determine treatment requirements for the respective end uses. There are different analytes that have been assembled into three different sample groupings as follows (Table C-6):

- COCs
- Moderate List, includes
    - COCs
    - Key Treatment Constituents
    - General chemistry

  - Treatment system (additional constituents that can influence performance of treatment system components)
  - Emergent compounds (additional emergent compounds identified in the 2010 Remedial Investigation (RI) Report (CH2M Hill, 2010) as Chemicals of Potential Concern)
- Long List; includes
  - Moderate list
  - Other permitting analytes

3.2.3 Groundwater Sampling Schedule

Groundwater samples will be collected from new PDI monitor wells after they are constructed and developed. The initial groundwater sample will be collected from new PDI monitor wells approximately 2 to 4 weeks after development is complete (Table C-4). A confirmation sample will be collected from new PDI monitor wells approximately 6 weeks after initial sample collection. Groundwater samples will also be collected on a quarterly basis from existing selected EPA/WRD monitor wells and from newly installed PDI monitor wells starting the quarter in which the first PDI monitor well is installed; quarterly sampling will continue until the quarter the last PDI monitor well is installed (Table C-4). A final PDI groundwater sampling event will be conducted at PDI monitor wells and the selected EPA/WRD monitor wells in the NE/CE Area in the quarter following the installation/initial sampling of the last PDI monitor well.

3.3 Aquifer Testing

Aquifer tests will be conducted to evaluate the hydraulic parameters of the hydrogeologic unit screened at each of the 24 PDI monitor wells in the NE/CE Area. Aquifer testing would be conducted in each of the PDI monitor wells installed in the candidate reinjection areas if the water quality results and preliminary well yields determined during development suggest that the respective candidate reinjection area is potentially viable for injection of treated groundwater. The aquifer test results for monitor wells within and adjacent to the target zone of the NE/CE Area extraction wellfield will be used to determine extraction rates required to meet capture zone performance standards for the NE/CE Area. The aquifer test results within the candidate reinjection areas would be used to evaluate viability of reinjection in the respective area. The following sections describe the testing in the NE/CE Area and the candidate reinjection area(s) as well as general well construction considerations to accommodate nominal 4-inch submersible pumps.

3.3.1 NE/CE Area

Aquifer tests will be conducted on each of the 24 PDI monitor wells installed in the NE/CE Area (Figure C-8) using constant rate discharge tests. This type of test provides more reliable data and associated estimates of hydraulic properties for aquifer type materials when compared to slug tests. The extraction rate will likely be between 5 and 60 gallons per minute (gpm) and will be determined based on well yield data collected during well development. The pumping phase of the aquifer test will be conducted for approximately 2 hours, followed by the recovery phase which will likely require a similar time as the pumping phase.

The locations of observation wells for each aquifer test has been compiled and will be verified/refined after the PDI monitor wells have been installed (Table C-7). Given the expected extraction rates (less than 60 gpm) and the distance between monitor wells constructed in the same hydrostratigraphic unit (typically over 500 feet), the observation wells were selected using the following general criteria: use the closest monitor well completed in the same hydrostratigraphic unit and use the monitor wells in the same well cluster as the pumped well. It is not expected that significant drawdown will be observed in observation wells completed in the same hydrostratigraphic unit, as such the transmissivity of the pumped well will be calculated based on water level drawdown and water level recovery in the pumped well.

3.3.2 Candidate Reinjection Area

If water quality and well yields during development support testing of the 4 PDI monitor wells installed in the primary candidate reinjection area, aquifer testing would be conducted. The aquifer testing would be conducted in a similar manner to the aquifer testing of NE/CE Area monitor wells.

The potential well development requirements for injection wells following construction and startup of the groundwater treatment system are difficult to assess using groundwater extraction tests. A short-term pilot injection test would be conducted to assess short-term fouling issues by conducting a pilot injection test over a period of several days.

If the evaluation of aquifer test data indicates that the aquifer in the respective candidate area may be suitable for treated water injection, a pilot injection test would be performed. To conduct this test, a pilot injection well would be drilled and installed a short distance from the monitor well that exhibited the lowest transmissivity. Further hydraulic testing would then be conducted at the pilot injection well, with the nearby monitor well serving as an observation well for those tests. Specifically, potable water will be injected at a rate to be determined based on results of monitor well hydraulic testing for a period of several days.

The locations of observation wells for each aquifer test has been compiled and will be verified/refined after the PDI monitor wells have been installed (Table C-7). Given the expected extraction rates (less than 60 gpm) and the distance between monitor wells constructed in the same hydrostratigraphic unit (typically over 500 feet), the observation wells were selected using the following general criteria: use the closest monitor well completed in the same hydrostratigraphic unit and use monitor wells in the same well cluster as the test well. It is not expected that significant drawdown will be observed in observation wells completed in the same hydrostratigraphic unit, as such the transmissivity of the test well will be calculated based on water level drawdown and water level recovery in the test well.

The primary observation well for the pilot test will be the monitor well adjacent to the pilot injection well.

3.3.3 Well Construction Considerations

The monitor wells will be constructed using nominal 4-inch casing and well screens. The inside diameter of nominal 4-inch casing is smaller for thicker walled casing. In the case of polyvinyl chloride (PVC), schedule 80 casing can be used to set casing to greater depths and avoid collapse during grouting. However, use of schedule 80 PVC casing will reduce the inside diameter of casing to less than 4 inches, which would not allow use of nominal 4-inch submersible pumps. If schedule 40 PVC casing cannot be used due to inadequate collapse strength, then a thinner walled stainless steel casing will be used to maintain the minimum 4-inch inside diameter requirement for well casing.

3.4 Lithologic Logging and Borehole Geophysical Logging

Lithologic and borehole geophysical logs will be obtained during the PDI field tasks and will be used in conjunction with other PDI and existing data to determine screen intervals of the PDI monitor wells, and to refine the understanding of the hydrostratigraphic units within the RDWA.

Lithologic and borehole geophysical logs will be obtained during the drilling of seven exploratory boreholes at PDI cluster well locations in the NE/CE Area (Figure C-9). The exploratory boreholes will be drilled to depths that extend to the deeper of the following two interpreted hydrostratigraphic intervals: the bottom of the Lynwood aquifer based on California Department of Water Resources (CDWR) Bulletin 104, or the bottom of Unit 6 based on the 2010 RI interpretation (Table C-5).

In addition, lithologic logs will be recorded during the construction of PDI monitor wells in the candidate reinjection area(s) as well as shallow monitor well CE-M4 MWA.

No core samples are expected to be collected for laboratory analysis of chemical constituents.

3.5 Investigation-Derived Wastes

Liquid and solid investigation-derived wastes (IDW) will be generated during: drilling, well development, hydraulic testing and sampling of the PDI monitor wells; during sampling of existing selected EPA/WRD monitor wells during the PDI; and during drilling of the exploratory borings. IDW will be managed in accordance with the attached SOPs (Attachment C-1).

4. FIELD METHODS AND PROCEDURES

The methods and procedures for the tasks included in Section 3.0 are briefly described in the following sections. Specific SOPs for many of these tasks are provided in Attachment C-1.

4.1 Access, Permitting, and Utility Clearance

Installation of monitor wells and ancillary structures as part of the PDI will require obtaining long-term access to work areas, securing any required permits from municipal government agencies, and assuring that PDI installations do not impinge upon existing utility lines or interfere with current land use.

Where possible, PDI monitor wells and other structures will be placed in public rights-of-way. The objective is to simplify access by minimizing the number of landowners that would need to approve well placement, and by minimizing the types of access agreements required. If necessary, private property owners will be contacted, and any access agreement requested by the property owner would be prepared by SWDs' representatives.

Application for any required permits for monitor well installation will be submitted in advance of field activities. It is anticipated that permit requirements will include encroachment and excavation permits issued by the relevant city and/or county public works agency, traffic control permits as needed, and monitor well construction permits issued by the Los Angeles County Department of Public Health, Environmental Health Drinking Water Program.

Prior to any subsurface work, proposed locations will be marked and Underground Service Alert will be notified. In addition, a qualified geophysical contractor will be retained to check proposed drilling locations for any subsurface infrastructure. Drilling locations will be moved as needed to avoid any identified or suspected utility lines. Finally, each drilling location will be hand augered or cleared using a vacuum air knife to a depth of 10 feet below land surface to verify that no utility lines or other obstructions are present.

4.2 Monitor Well Installation

Methods and procedures for monitor well construction are detailed in the SOPs (Attachment C-1). Methods for surveying monitor wells are detailed in SOP Attachment C-2. The following sections briefly describe these methods and procedures.

4.2.1 Drilling and Construction

Exploratory borings will be drilled using mud rotary drilling techniques. Monitor wells will be drilled and constructed using mud rotary, sonic, or conventional hollow-stem auger techniques, as appropriate. Exploratory borings will be converted to monitor wells following downhole geophysical logging.

4.2.1.1 Exploratory Borings

At each of the seven locations where PDI monitor well clusters are recommended in the NE/CE Area, an exploratory boring will be drilled first. Locations and target depths for proposed exploratory borings have been provided (Table C-5; Figure C-9). Drilling procedures for mud rotary boreholes are detailed in the SOPs (Attachment C-1). Once the total depth has been reached, the drilling mud will be conditioned as needed, and a qualified downhole geophysical contractor will conduct a survey consisting of the following:

- Spontaneous potential;
- 16-inch normal resistivity, 64-inch normal resistivity;
- lateralog-3;
- Caliper; and
- Gamma ray.

Additional downhole geophysical logs may be requested as determined by the PDI Project Manager or the Field Task Manager in consultation with the PDI Project Manager.

Based on a review of geophysical logs, the final screened interval for the deepest monitor well in that cluster will be determined. If needed, the bottom of the exploratory borehole will be backfilled using bentonite pellets or bentonite grout, as appropriate. The exploratory boring will then be converted into a monitor well screened in the deepest aquifer targeted for that well cluster (Table C-5).

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4.2.1.2 Borehole Drill Cuttings and/or Core Sample Collection

For deep mud rotary boreholes, drill cuttings will be collected for lithologic logging over 10-foot intervals as drilling fluids are circulated through the borehole. For shallower monitor wells constructed at the same location as deep mud rotary boreholes, the lithologic log from the deep mud rotary borehole will be used. For shallower monitor wells constructed in areas where no deep mud rotary boreholes have been drilled, lithologic logging will be conducted using split-spoon samples collected at 5-foot intervals when drilling using hollow-stem auger methods or using core retrieved from the drill rod when drilling using sonic drilling methods. The drill cuttings will be logged onsite by an experienced field staff in accordance with the attached SOPs (Attachment C-1). Downhole soil samples will not be collected for laboratory analysis. Following completion of the boring, drill cutting samples will be managed in accordance with the attached SOPs (Attachment C-1).

Core samples may be collected during drilling of the first, and deepest, monitor well following completion of the exploratory boring / converted monitor well. Core samples may be depth discrete or continuous core, as appropriate. For hollow-stem auger drilling methods, core samples would be collected using a split-spoon sampler. For mud rotary drilling methods, core samples would be collected using a pitcher tube sampler or a steel core sampler inserted into a wireline core barrel. If sonic drilling methods are used, continuous core would be extruded as each section of hollow drill rod is advanced. Procedures for core sample collection are detailed in the SOPs (Attachment C-1).

Evaluation of cuttings and/or core samples may be used to modify final monitor well design, including screen slot size and filter pack size.

4.2.1.3 Monitor Wells

Monitor wells will be drilled using mud rotary, sonic, or conventional hollow-stem auger techniques, as appropriate, using methods in the SOPs (Attachment C-1). The anticipated length and depth of screened intervals for each monitor well cluster has been provided (Table C-5). The actual screened interval will be determined based on water level data obtained from existing nearby wells prior to commencing drilling, on an evaluation of geophysical logs obtained from the adjacent exploratory boring, and on lithologic data obtained during drilling. In order to have a better understanding of hydrostratigraphic units in the NE/CE Area, it is recommended that the shallower monitor wells in the NE/CE Area not be installed until all seven exploratory boreholes have been logged and the deepest monitor well at each cluster has been installed and sampled.

Monitor wells are constructed using nominal 4-inch diameter schedule 40 PVC or schedule 10 stainless steel well casing (Table C-8). The well casing material and wall thickness may be adjusted by calculating grout pressure at the bottom of the annular seal (factoring grout density and depth to water in casing) and comparing to resistance to hydraulic collapse pressure (factoring in heat of hydration for PVC casing), assuming that the annular seal will be placed in one continuous grouting operation. As outlined in Section 3.3.3, schedule 80 PVC casing is not planned for monitor well construction due to the smaller inside diameter of the casing and conflict with nominal 4-inch diameter submersible pumps used for aquifer testing.

The screened interval will consist of 0.010- or 0.020-inch stainless steel wire-wrap screen. The actual screen slot size and filter pack size may be adjusted based on an evaluation of drill cuttings, which will be collected during drilling of the first, and deepest, monitor well following completion of the exploratory boring / converted monitor well. Screen slot size and filter pack size may also be modified based on physical examination of lithologic samples collected during drilling of that monitor well. Emplacement procedures for well screen, well casings, filter pack, and annular seals are detailed in the SOPs (Attachment C-1).

4.2.2 Well Development

Newly constructed monitor wells will be developed initially during emplacement of the filter pack using methods in the SOPs (Attachment C-1). Final development of newly constructed monitor wells will occur within approximately 2 weeks, but no sooner than 72 hours after completing well construction using a combination of conventional bailing, surging, and pumping techniques, or using an alternative method approved by the PDI Project Manager or the Field Task Manager in consultation with the PDI Project Manager. Temperature, pH, and electrical conductivity (EC) will be monitored during final monitor well development in accordance with the SOPs (Attachment C-1).

Water generated during well development will be containerized at each well location using Baker-type storage tanks. Procedures for handling, characterization, and disposal of wastes are detailed in the SOPs (Attachment C-1).

4.3 Aquifer Testing

Aquifer tests will be conducted to evaluate the hydraulic parameters of the hydrogeologic units screened by PDI monitor wells using procedures outlined in the SOPs (Attachment C-1). Water level drawdown, recovery, and well discharge rates will be monitored throughout the test. Water levels will also be monitored in any observation wells identified for a particular test (Table C-7). The water quality parameters temperature, EC, dissolved oxygen (DO), oxidation-reduction potential (ORP), and pH of discharged water may also be monitored periodically. Aquifer testing will not be conducted in monitor wells where available pumping data indicate that the well cannot sustain a pumping rate above 5 gpm. Water level recovery data will be obtained from the monitor well in which the test is performed and the designated observation wells. Procedures for aquifer testing are detailed in the SOPs (Attachment C-1).

It is anticipated that each aquifer test will be a 2-hour duration, constant-discharge pumping test. The pumping rate will be determined based on review of well development pumping data, as well as available data for nearby monitor wells screened within the same aquifer. A pump of appropriate size and capability will be temporarily installed in the monitor well, with the intake set above the screened interval, or within the screened interval if the monitor well is screened at or near the water table. Pumped water will be directed into a Baker-type storage tank for characterization and disposal. Appropriate instruments will be used to measure the pump discharge rate, and the flowrate will be adjustable to maintain the specified rate. Pressure transducers may be used alongside manual water level measurements to provide a detailed drawdown and recovery record for the tested well. Manual water level measurements would be made in accordance with the schedule provided in Table C-9.

4.4 Injection Testing

Injection tests may be conducted to evaluate the suitability of a specific hydrostratigraphic unit or units for injection of treated groundwater using methods in the SOPs (Attachment C-1). Locations and depths of monitor wells to be installed to evaluate potential injection well locations have been provided (Table C-5; Figure C-5). Preliminary evaluation of hydraulic parameters of the hydrogeologic unit(s) selected for injection at a given location may be accomplished by hydraulic testing of monitor wells (Section 4.3).

If the results of short-term extraction tests indicate reinjection is viable in the respective candidate reinjection area, then a pilot injection test would be conducted in the respective area. A pilot injection well would be drilled and installed a short distance (approximately 10 to 50 feet to the extent practical) from one of the monitor wells, specifically that monitor well exhibiting the lowest transmissivity. Review of the results of hydraulic testing would be used to determine the location and depth of the pilot injection well. The pilot injection well would be installed using sonic drilling methods. The pilot injection well would be constructed and installed in a similar manner as PDI monitor wells, with the exception that well screen and casing would be

6 inches in nominal diameter. In this case, Schedule 80 PVC blank casing would be used with a stainless steel screen comprised of continuous wire-wrap construction.

Further hydraulic testing would then be conducted at the pilot injection well, with the nearby monitor well serving as the primary observation well for the test. For an injection test, a reliable supply of potable water will be identified, and necessary conveyances (piping, valves, filters, etc.) will be installed as appropriate. The flowrate of potable water into the well will be adjustable, and the injection rate determined by review of existing hydraulic test data. The test injection well and observation well will be fitted with pressure transducers and manually measured according to schedules specified in Table C-9. Water levels and well injection rates will be monitored throughout the injection and recovery portions of the test. The duration of pilot injection testing, and monitoring of water level recovery, will be determined based on review of primary hydraulic testing data. Procedures for injection testing are detailed in the SOPs (Attachment C-1).

4.5 Water Level Monitoring

Water levels will be measured using calibrated electric water level indicators. Depth to water will be measured from surveyed reference points. Water level elevations will be calculated as the difference between the surveyed or estimated reference point elevation and the depth to water for each well. Water level data will be recorded on preprinted water level data sheets (Attachment C-1). Water level measuring equipment will be decontaminated between measurements at wells. Methods and procedures for water level measurement are detailed in the SOPs (Attachment C-1).

Nearly continuous monitoring of water levels in selected wells will be conducted using pressure transducers. Transducers will be programmed with the measurement interval of 15 minutes for monitoring conducted over a period of a week or more or at more frequent intervals such as those specified for aquifer testing. The pressure transducer will be suspended in the respective monitor well using coated wire of a known length. Manual water level measurements will be used to calibrate the automatic transducer measurements. Methods and procedures for water level monitoring using pressure transducers are detailed in the SOPs (Attachment C-1).

4.6 Groundwater Monitoring

Representative groundwater samples will be collected for chemical analysis of COCs and other constituents specified for the PDI (Table C-4). The temperature, pH, EC, DO, ORP, and turbidity of the purge water will be measured to ensure that they have stabilized prior to sampling. Where practicable, monitor wells will be sampled using low-flow / minimal drawdown methods. Methods and procedures for collecting groundwater samples are detailed in the SOPs (Attachment C-1). The following sections briefly describe these methods and procedures.

4.6.1 Groundwater Sample Collection – Low-Flow / Minimal Drawdown Method

Existing and newly constructed monitor wells will be sampled using low-flow / minimal drawdown methods, unless it is not possible due to an insufficient water column or other condition encountered at the well. Groundwater samples will be collected through dedicated discharge tubing. The monitor well will be purged at a sufficiently low flowrate to minimize turbulence and ensure minimal drawdown, generally less than about 0.3 foot, with the goal of minimizing potential mixing with the overlying stagnant water column and reducing disturbance and stress to the water column in the well and the water-bearing zone being sampled. A variable speed controller will be used to control the flowrate during the purge and when collecting samples. Groundwater samples will be collected in accordance with the SOPs (Attachment C-1) and in general accordance with California Department of Toxic Substances Control (DTSC) guidance (DTSC, 2008). Analytical parameters, container requirements, preservatives, and holding time limits for groundwater samples have been summarized (Tables C-10 and C-11).

4.6.2 Groundwater Sample Collection – Multiple Casing Volume Purge Method

In the event that low-flow purging is not practicable for a particular monitor well, a minimum of three casing volumes of water will be purged from the well prior to sampling if the well yields sufficient groundwater to remove three casing volumes within approximately 90 minutes. If the monitor well yield is insufficient, one casing volume will be purged. If even one casing volume cannot be purged within 90 minutes, the well will be purged until the water draws down to the pump intake and pumping will be discontinued. The well should be allowed to recover for 2 hours after purging has stopped. Then the well should be sampled as soon after 2 hours as possible. Analytical parameters, container requirements, preservatives, and holding time limits for groundwater samples have been summarized (Tables C10 and C-11).

4.6.3 Sample Containers, Preservation, and Transmittal

The types and volumes of sample containers used for groundwater sampling have been summarized (Table C-11).

Groundwater sample containers will be clearly labeled with appropriate identification immediately after sample collection. Groundwater samples for laboratory analysis will be stored on ice in an ice chest for transmittal to the project analytical laboratory. A chain-of-custody record and analytical schedule will accompany each sample shipment to the laboratory. Sample control, sample handling, and chain-of-custody procedures will be performed in accordance with the SOPs (Attachment C-1).

4.7 Characterization and Disposal of Investigation-Derived Wastes

All IDW generated from activities described in this PDIWP will be containerized, properly labeled, and temporarily stored at an appropriate location to be determined within the Work Area. Samples will be collected for waste profiling and sent to a California-certified laboratory for analysis in accordance with California Code of Regulations, Title 22, Section 66261.24. Following waste profiling, the IDW will be transported by a licensed waste hauler for disposal at an appropriately permitted solid or hazardous waste facility in accordance with Federal and State requirements. IDW will be stored for no more than 60 days during characterization and consolidation. Handling of IDW, including drill cuttings, fluids, and produced water, is described in the SOPs (Attachment C-1).

4.8 Field Variances

As conditions in the field may vary, it may become necessary to implement minor modifications to drilling, well installation, hydraulic testing, and groundwater sampling as described in this FSP.

Variances relating to the location of PDI monitor wells may be identified during access and/or permitting constraints. To the extent that PDI monitor well locations vary more than approximately 200 feet from the location presented in this FSP, the PDI Project Manager will notify the SWDs' Project Coordinator of any new proposed location; the SWDs' Project Coordinator will in turn notify the EPA Project Manager. The EPA Project Manager's concurrence on the revised well location will be obtained prior to installing the respective PDI monitor well(s).

For other variances, when appropriate, the PDI Project Manager will be notified and verbal approval will be obtained before implementing the changes. The PDI Project Manager will notify the SWDs' Project Coordinator, who will notify the EPA Project Manager of major modifications or variances to the field program. Modifications to the procedures presented in this FSP will be documented on the Field Observation Form and on other task-specific forms as applicable (Attachment C-1). Significant modifications will be documented in the appropriate final report for that field activity or program.

4.9 Quality Assurance

In general, QA during PDI field activities described in this FSP will be accomplished by following the relevant SOPs (Attachment C-1). Detailed QA/QC procedures, particularly with respect to sample collection and analysis, are provided in the QAPP. Laboratory QA procedures are specified in the laboratory's QA Manual, and evaluation of laboratory QA documentation is described in the QAPP.

4.9.1 Quality Assurance Objectives for Measurement Data

QA procedures for collecting field measurement data will be performed in accordance with the QAPP and SOPs (Attachment C-1).

4.9.2 Field Quality Assurance Samples

QA samples will be collected or prepared to assist in determining data reliability. QA samples include field duplicates and blanks. Field QA samples are typically collected from locations that are suspected to be moderately impacted by COCs. QA samples will be collected concurrent with and using the same procedures as the collection of the corresponding original groundwater sample.

A field duplicate is a groundwater sample collected as close as possible to the original sample time from the same source, and is used to evaluate sampling precision. Field duplicates will be labeled and packaged in the same manner as other samples so that the laboratory cannot distinguish between original samples and duplicates. Field duplicates will be collected by alternately filling sample and sample duplicate containers at the location being monitored. Each duplicate will be handled using the same sampling and preservation method as original samples. Field duplicates will be collected at a frequency of 10 percent, or 1 for every 10 groundwater samples. Duplicate samples will be analyzed for the same constituents as the corresponding original samples.

One trip blank sample will be submitted with each shipment to the analytical laboratory, and will be analyzed for VOCs. Trip blanks will be prepared by the analytical laboratory using reagent-free deionized water. The purpose of the trip blank is to identify possible contamination associated with container preparation and sample transport.

One field blank water sample will be submitted each day that sampling is conducted for analysis of VOCs. Field blank samples are collected to verify that contamination is not introduced to samples during collection, handling, or shipping of the samples, and to evaluate decontamination procedures, if applicable. Laboratory-provided reagent-free deionized water will be used. Field blanks will be prepared and labeled in the same manner as the original groundwater samples and sent "blind" to the laboratory. If sampling equipment is decontaminated and reused in the field (e.g., a temporary pump), an equipment blank will be collected. Otherwise, a field blank will be collected for that day.

An equipment blank, also known as a rinsate blank, is collected by pouring the laboratory-provided reagent-free deionized water into or over the decontaminated sampling equipment, then transferring the water to the appropriate sample containers. A field blank is collected by pouring the blank water directly into the appropriate sample containers at the sample location. The same preservation methods, packaging, and handling procedures as those used during collection of original groundwater samples will be used.

4.9.3 Laboratory Quality Control Samples

Laboratory QC samples will be collected to perform matrix spike (MS) / matrix spike duplicate (MSD) analyses. An MS is an aliquot of a sample spiked with a known concentration of target analyte(s) and provides a measure of accuracy. The MSD is a laboratory split sample of the MS and is used to determine the precision of the method. The MS and MSD analysis will be conducted in accordance with the laboratory QA/QC program as attached to the QAPP. If the laboratory requires additional water for the laboratory QC samples, the Laboratory Project Manager will notify the PDI Project Manager and Project QA Manager and indicate the required volume of water for QC samples. The Project QA Officer will work with the Field Task Manager to ensure that the appropriate volume of water is collected.

4.9.4 Special Training Requirements and Certifications

The training requirements and certifications associated with QA/QC roles in the PDI project and the designated analytical laboratory for the project include:

- Data Validation Project Manager: Data review and validation will be performed by technical personnel experienced with the requirements of the EPA National Functional Guidelines for Inorganic and Organic Data Review.
- Laboratory: The designated analytical laboratory will be certified for all analyses performed for the PDI, under the SWRCB ELAP to perform laboratory analyses for methods specified in this FSP and associated QAPP. It is preferred

that the laboratory currently participates in the EPA Performance Evaluation Test Program and provides proof of performance.

- Laboratory Project Manager: One project manager will be designated by the laboratory for the PDI analysis program. The Laboratory Project Manager will have experience with similar projects.

4.9.5 Sample Identification

Naming conventions for PDI samples are specified here based on the need for unique identifiers for each sample date and location.

For original groundwater samples, the convention will be:

- [Well Identifier]_YYYYMMDD

As an example, an original sample collected from monitor well EPA__MW25C on July 4, 2016, would be entered as:

- EPA__MW25C-20160704

For duplicate groundwater samples, the suffix "00" will be added to the well cluster number, so a duplicate of the above sample would be entered as:

- EPA__MW2500C_20160704

For trip blanks, the convention will be:

- TB[sequential letter]_YYYYMMDD

As an example, the second trip blank submitted with samples collected on July 4, 2016, would be entered as:

- TBB_20160704

For equipment rinsate blanks, the convention will be:

- RB_YYYYMMDD

Note that only one rinsate or field blank will be collected for each day of sampling. As an example, the rinsate blank collected on July 4, 2016, would be entered as:

- RB_20160704

For field blanks, the convention will be:

- FB_YYYYMMDD

As an example, the field blank collected on July 4, 2016, would be entered as:

- FB_20160704

Samples collected for characterization of IDW will be identified by the waste medium and sample collection date. For samples of drilling mud or soil cuttings stored in a rolloff bin or 55-gallon drum, the convention will be:

- For Bin: BIN_[bin number]_YYYYMMDD
- For 55-gallon drum: Drum_[IDW Container Identifier]_YYYYMMDD

As an example, a sample of soil cuttings collected from rolloff bin #112233, 55-gallon drum PDI/GWM01 (from IDW Container Identifier on drum label) collected on July 4, 2016, would be entered as:

- For Bin: BIN_112233_20160704
- For Drum: Drum_PDI/GWM01_20160704

If a soil cuttings sample represents a composite sample of two or more containers, the bin or drum number above would be replaced by “COMP”. The container numbers would be recorded in the field notebook.

For samples of produced water stored in a Baker-type tank, the convention will be:

- WW[sequential letter]_YYYYMMDD

As an example, the first sample of wastewater collected on July 4, 2016, would be entered as:

- WWA_20160704

The source(s) of sampled water would be recorded in the field notebook.

4.9.6 Documentation and Record Keeping

This section briefly identifies field and laboratory records required for the PDI, the information to be included in reports, the format for reporting data in analytical data report packages, and the document control procedures to be used.

Field records include field observation forms, lithologic log forms, health and safety briefing log forms, other task-specific forms, chain-of-custody forms, and contractor daily sheets. These field records will be bound in a field notebook assembled for the specific task or activity. The field notebook will be the responsibility of the field team leader. All entries will be signed and dated, and the field notebook will be kept as a permanent record. Other field records include photographs, geophysical logs, and downloaded data from pressure transducers or other instruments; these records are maintained in electronic format. Specific documentation requirements and applicable field forms for each activity are detailed in the SOPs (Attachment C-1) and in the HASP.

Records provided by the analytical laboratory include laboratory reports and QA/QC records. All analytical results for groundwater samples will be reported in the laboratory's approved format. In addition to the reported data, the laboratory data report will, at a minimum, include a narrative that will discuss any problems or discrepancies, and will provide sufficient calibration and QA/QC information to determine that the method was within control limits at the time that the samples were analyzed. Laboratory records will be provided in electronic format, both as .pdf reports and as electronic data deliverables. Specific documentation requirements for the laboratory are detailed in the QAPP and in the laboratory's QA Manual (Attached to QAPP).

Reporting requirements for the PDI have been specified in the PDIWP. With respect to field and laboratory records, data relevant to the interpretation of hydrogeological and water quality conditions at the Site will be summarized in either tabular and/or graphic format. Lithologic logs will be compiled based on field notes and provided in the PDI Report submitted to EPA. Geophysical logs will be provided as an appendix to the PDI Report. Laboratory analytical reports will be provided as an appendix to the PDI Report.

A digital archive of the PDI will be maintained by Contractors conducting the PDI activities until the PDI is complete, at which time the digital archive will be transferred to the SWDs' Project Coordinator. Field forms recorded in field notebooks will be scanned and archived electronically. Field records in electronic format will also be archived. Documents received electronically, including geophysical logs and laboratory reports, will be archived in electronic format. Reports submitted to EPA, and all associated correspondence, will be maintained in the electronic archive. In addition, a database containing well construction data, manual water level data, and water quality data will be prepared and maintained in the electronic archive for the PDI. The database will be maintained by ddms, inc.

4.10 Health and Safety

Health and safety during PDI field activities will be addressed by adhering to the provisions of the HASP prepared for the PDI (Appendix E).

5. REFERENCES CITED

California Environmental Protection Agency, Department of Toxic Substances Control (DTSC), 2008. Representative Sampling of Groundwater for Hazardous Substances – Guidance Manual for Groundwater Investigations. July 1995, Revised February 2008.

CH2M Hill, 2010. Final Remedial Investigation / Feasibility Study Reports, Omega Chemical Corporation Superfund Site, Operable Unit 2, Los Angeles County, California. August 2010.

U.S. Environmental Protection Agency (EPA), 2008. Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, EPA-540-R-08-01, June.

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_____, 2011. Interim Action Record of Decision, Omega Corporation Superfund Site, Operable Unit 2, Los Angeles County, California, EPA ID: CAD042245001. September 20, 2011.

_____, 2016. Consent Decree regarding Operable Unit 2 at the Omega Chemical Corporation Superfund Site, Case 2:16-cv-02696 Document 4-1. Filed with United States District Court, Central District of California, Western Division. April 20, 2016.

APPENDIX C TABLES

TABLE C-1

Main Chemicals of Concern and Key Treatment Constituents

Main Chemicals of Concern (COCs)	
Volatile Organic Compounds	Trichloroethene (TCE)
	Tetrachloroethene / Perchloroethene (PCE)
	Trichlorofluoromethane (Freon 11)
	1,1,2-Trichloro-1,2,2,-trifluoroethane (Freon 113)
	1,1-Dichloroethene (1,1-DCE)
	cis-1,2-Dichloroethene (cis-1,2-DCE)
	chloroform
	carbon tetrachloride
	1,1-Dichloroethane (1,1-DCA)
	1,2-Dichloroethane (1,2-DCA)
	1,1,2-Trichloroethane (1,1,2-TCA)
Other	1,4-dioxane
	hexavalent chromium

Key Treatment Constituents	
Metals	Aluminum
	Total Chromium
	Manganese
	Selenium
General Chemistry	Nitrate
	Sulfate
	Total dissolved solids
Other	bis(2-Ethylhexyl)phthalate
	Perchlorate

TABLE C-2

SUMMARY OF CORRELATION BETWEEN PRE-DESIGN INVESTIGATION REQUIREMENTS AND PLANNED TASKS

CD SOW Requirements for Data Evaluation [CD SOW Section 3.3(a)(i- iv)]	Data Needed		Task Identified to Collect Data	Data To Be Collected
(i) Define the areas and depths targeted for hydraulic control in the NE and CE Areas	Analytical results for COCs to define target zones in NE/CE Area		2,3	Initial and confirmation groundwater samples analyzed for COCs from 24 new PDI monitor wells in respective areas
			6	Periodic groundwater samples analyzed for COCs from 24 new PDI monitor wells and selected existing EPA/WRD monitor wells in respective areas
(ii) Estimate hydraulic conductivity in the NE/CE Area capture zone	Hydraulic conductivity and transmissivity of the target hydrostratigraphic units		5	Hydraulic testing of 24 new PDI monitor wells in vicinity of respective areas.
(iii) Select groundwater extraction rates and locations for design of the remedy	Target zone defined from SOW item i above		2,3,6	See above
	Hydraulic testing from SOW item ii above		5	See above
	Direction of groundwater flow and hydraulic gradients		1,2,3 and 6	Periodic/transducer water level measurements in EPA/WRD monitor wells and 24 new PDI monitor wells
(iv) Address any concerns about the quantity, quality, completeness, or usability of water quality or other data upon which the design will be based	Refine understanding of hydrostratigraphic units	Borehole geophysical logs and lithologic logs	2,3,4	Geophysical and/or lithologic logs from 7 exploratory boreholes and monitor wells in NE/CE Area and lithologic logs from 4 monitor wells in candidate reinjection area
		Similarities/differences in water level elevations/trends in monitor wells	1, 2, 3, 4, 6	Periodic/transducer water level measurements in existing EPA/WRD wells and 28 new PDI wells
	Treated groundwater End Use evaluation	Key treatment constituents, emergent compounds and permit water quality parameters from extraction well field	2,3,6	Confirmation and contemporaneous groundwater samples analyzed for wide suite of constituents from 24 new PDI monitor wells and contemporaneous groundwater samples analyzed for wide suite of constituents selected EPA/WRD monitor wells in respective areas
		COC, key treatment constituents, emergent compounds and permit water quality parameters in vicinity of reinjection well field	4	Initial and confirmation groundwater samples analyzed for COCs and confirmation sample analyzed for wide suite of constituents from 4 new PDI monitor wells in respective area
		Hydraulic properties and potential injection well fouling	5	Hydraulic testing of 4 new PDI monitor wells and pilot injection of potable water into 1 PDI pilot injection well in respective area
		Capacity of reclaim and spreading basins	NA	Meet with owner/operators of reclaim and spreading basin
		Permitting requirements for respective end use	NA	Meet with permitting agencies for reinjection, reclaim and spreading basin
	Treatment System Design	Influent Flow using information from SOW item iii above	1,2,3,5,6	See above
		COC influent concentration	2,3,5,6	Combination of groundwater samples collected from monitor wells within the NE/CE target zone and respective estimated groundwater extraction rates
		Key treatment constituents, treatment system design, emergent compounds and permit water quality parameters to meet end use requirements	2,3,5,6	Use permitting requirements for respective end use and results of groundwater samples collected and analyzed for wide suite of compounds, including but not limited to water quality parameters influencing performance of respective treatment system process, from monitor wells within the NE/CE target zone and respective estimated groundwater extraction rates

CD Consent Decree lodged April 20, 2016 covering Operable Unit 2 at the Omega Chemical Corporation Superfund Site
CE Central extraction area (The location of the CE area is depicted in Appendix C of the CD as the area between the NE and Telegraph Road.)
COCs Chemical of Concern
EPA United States Environmental Protection Agency
NE Northern extraction area (The location of the NE area is depicted in Appendix C of the CD in the vicinity of Sorenson Avenue)
PDI Pre-Design Investigation
WRD Water Replenishment District of Southern California

TABLE C-3

EXISTING AND PRE-DESIGN INVESTIGATION WATER LEVEL MONITORING PROGRAM

Well Identifier	AREA	LSE (feet msl)	MPE (feet msl)	Screen Interval (feet bls)	HydroUnit		OBJECTIVES			MONITORING METHOD		
					EPA	DWR	HSU[a]	NE/CE[b,c]	INJ[d]	Early Transducer[1]	PDI Transducer[2]	Periodic Manual[3]
EXISTING												
MW-1A	RD	157.8	157.71	45 - 60	2	Gs	S					X
MW-1B	RD	158.1	158.05	75 - 85.4	2, 3	Gs	S					X
MW-2	RD	154.2	154.21	45 - 60	2	Gs	S	X				X
MW-3	RD	151.9	151.48	38 - 48	2	UN	S					X
MW-4A	RD	147.0	146.80	42.7 - 53	2	Gs	S	X				X
MW-4B	RD	147.0	146.84	69.7 - 80	3	Gs	S	X				X
MW-4C	RD	147.4	147.10	88.7 - 99	3	H	S	X				X
MW-5	RD	150.8	150.60	43.3 - 53.3	2	Gs	S	X				X
MW-6	RD	150.4	150.28	37.1 - 47.5	2	Gs	S	X				X
MW-7	RD	143.6	143.28	35.8 - 46	2, 3	Ga	S					X
MW-8A	NE	150.4	150.14	30 - 45	2	Gs	S	X				X
MW-8B	NE	150.3	150.03	65 - 75	3	Gs	P	X		X		X
MW-8C	NE	150.3	150.03	86.7 - 91.7	3	Gs	S	X				X
MW-8D	NE	150.1	149.91	110 - 120	3, 4	H	P	X		X		X
MW-9A	RD	148.9	148.84	25 - 35	2	Gs	S	X				X
MW-9B	RD	149.1	148.90	49.8 - 60	2	Gs	S	X				X
MW-10	RD	147.4	147.45	52 - 62	3	Ga	S	X				X
MW-11	RD	150.9	150.89	40 - 50	3	Ga	S	X				X
MW-12	RD	220.5	220.87	82 - 97	2, 3	UN	S					X
MW-13A	RD	206.3	206.02	56 - 66	2	UN	S					X
MW-13B	RD	206.3	205.88	123 - 133	3, 4	UN	S					X
MW-14	RD	173.0	172.63	60 - 75	2	Gs	S					X
MW-15	RD	148.7	148.28	50 - 70	2, 3	Gs	S	X				X
MW-16A	RD	153.5	153.19	45 - 60	3	Ga	S	X				X
MW-16B	RD	153.5	153.19	106 - 116	4, 5	H	P	X		X		X
MW-16C	RD	153.5	153.26	149 - 164	6	J-L UN	S	TBD				X

HARGIS + ASSOCIATES, INC.

TABLE C-3

EXISTING AND PRE-DESIGN INVESTIGATION WATER LEVEL MONITORING PROGRAM

Well Identifier	AREA	LSE (feet msl)	MPE (feet msl)	Screen Interval (feet bls)	HydroUnit		OBJECTIVES			MONITORING METHOD		
					EPA	DWR	HSU[a]	NE/CE[b,c]	INJ[d]	Early Transducer[1]	PDI Transducer[2]	Periodic Manual[3]
EXISTING (continued)												
MW-17A	RD	159.4	159.03	56 - 71	3	Ga, H	S	X				X
MW-17B	RD	159.4	158.90	94 - 104	4	H	P	X		X		X
MW-17C	RD	159.4	159.00	172 - 182	6	L	P	X		X		X
MW-18A	NE	144.3	143.73	56 - 71	3, 4	H	P	X		X		X
MW-18B	NE	144.3	143.83	90 - 100	5	H-J UN	S	X				X
MW-18C	NE	144.3	143.83	146 - 161	6	J-L UN	P	X		X		X
MW-19	RD	159.0	158.73	56 - 71	3	Ga	S					X
MW-20A	CE	142.1	141.31	75 - 90	3	Ga	S	X				X
MW-20B	CE	142.1	141.32	122 - 132	4	H	P	X		X		X
MW-20C	CE	142.1	141.35	180 - 190	6	J	P	X		X		X
MW-21	RD	129.3	128.81	64 - 79	3	Gs	S	X				X
MW-22	RD	151.5	150.82	74 - 89	3	Ga-H UN	S					X
MW-23A	NE	149.1	148.76	35 - 55	2	Gs	S	X				X
MW-23B	NE	149.4	149.06	82 - 97	3	Gs	P	X		X		X
MW-23C	NE	149.4	149.07	145 - 160	5	J	P	X		X		X
MW-23D	NE	149.4	148.04	175 - 185	6	J-L UN	P	X		X		X
MW-24A	RD	162.4	162.04	50 - 70	2	Gs	P			X		X
MW-24B	RD	162.4	162.03	110 - 125	3	Ga-H UN	S					X
MW-24C	RD	162.4	162.02	140 - 160	4, 5	J	P			X		X
MW-24D	RD	162.4	162.05	173 - 178	6	L	S					X
MW-25A	NE	148.3	147.90	45 - 65	3	Ga	S	X				X
MW-25B	NE	148.3	147.84	90 - 110	4, 5	H	P	X		X		X
MW-25C	NE	148.3	147.86	140 - 150	6	J-L UN	S	X				X
MW-25D	NE	148.3	147.87	194 - 209	Deep	L	P	X		X		X

TABLE C-3

EXISTING AND PRE-DESIGN INVESTIGATION WATER LEVEL MONITORING PROGRAM

		LSE	MPE	Screen	HydroUnit		OBJECTIVES			MONITORING METHOD		
				Interval						Early	PDI	Periodic
Well Identifier	AREA	(feet msl)	(feet msl)	(feet bls)	EPA	DWR	HSU[a]	NE/CE[b,c]	INJ[d]	Transducer[1]	Transducer[2]	Manual[3]
EXISTING (continued)												
MW-26A	RD	156.0	155.62	70 - 90	3	H	P			X		X
MW-26B	RD	156.0	155.45	105 - 120	4	H	S					X
MW-26C	RD	156.0	155.41	145 - 160	6	J	P			X		X
MW-26D	RD	156.0	155.37	185 - 205	6	L	P			X		X
MW-27A	RD*	139.5	139.24	90 - 110	3	Ga	P	X		X		X
MW-27B	RD*	139.5	139.18	144 - 164	4	H	P	X		X		X
MW-27C	RD*	139.5	139.17	180 - 190	5	H	P	X		X		X
MW-27D	RD*	139.5	139.13	200 - 210	5, 6	H-J UN	P	TBD		X		X
MW-31	RD	233.0	232.67	106 - 121	3	UN	S					X
SFS_Hawkins_1a_1	RD	147.8	147.40	480 - 490	Deep	Deep	P			X		X
SFS_Hawkins_1b_2	RD	147.8	147.30	378 - 388	Deep	Deep	P			X		X
SFS_Hawkins_1c_3	CE	147.8	147.19	286 - 296	Deep	L	P	X		X		X
SFS_Hawkins_1c_4	CE	147.8	147.18	242 - 252	6	J-L UN	P	X		X		X
SFS_Hawkins_1c_5	CE	147.8	147.20	168 - 178	5	H-J UN	P	X		X		X
PRE-DESIGN INVESTIGATION MONITOR WELL												
NE-1 MWA	NE	TBD	TBD	50 - 100	2/3	Gs	P	X			X	X
NE-1 MWB	NE	TBD	TBD	120 - 150	3	H	P	X			X	X
NE-1 MWC	NE	TBD	TBD	160 - 180	4	J	P	TBD			X	X
NE-1 MWD	NE	TBD	TBD	200 - 250	5/6	L	P	TBD			X	X
NE-2 MWA	NE	TBD	TBD	50 - 90	2	Gs	P	X			X	X
NE-2 MWB	NE	TBD	TBD	100 - 120	3	H	P	X			X	X
NE-2 MWC	NE	TBD	TBD	130 - 150	4	J	P	TBD			X	X
NE-2 MWD	NE	TBD	TBD	200 - 250	5/6	L	P	TBD			X	X

TABLE C-3

EXISTING AND PRE-DESIGN INVESTIGATION WATER LEVEL MONITORING PROGRAM

Well Identifier	AREA	LSE (feet msl)	MPE (feet msl)	Screen Interval (feet bls)	HydroUnit		OBJECTIVES			MONITORING METHOD		
					EPA	DWR	HSU[a]	NE/CE[b,c]	INJ[d]	Early Transducer[1]	PDI Transducer[2]	Periodic Manual[3]
PRE-DESIGN INVESTIGATION MONITOR WELL (continued)												
NE-3 MWA	NE	TBD	TBD	50 - 70	2	Ga	P	X			X	X
NE-3 MWB	NE	TBD	TBD	80 - 100	3	H	P	X			X	X
NE-3 MWC	NE	TBD	TBD	120 - 140	4	J	P	TBD			X	X
CE-1 MWA	CE	TBD	TBD	100 - 120	3/4	WT	P	X			X	X
CE-1 MWB	CE	TBD	TBD	140 - 170	4	H	P	X			X	X
CE-1 MWC	CE	TBD	TBD	200 - 250	5/6	J	P	TBD			X	X
CE-2 MWA	CE	TBD	TBD	100 - 120	3/4	WT	P	X			X	X
CE-2 MWB	CE	TBD	TBD	140 - 170	4	H	P	X			X	X
CE-2 MWC	CE	TBD	TBD	200 - 250	5/6	J	P	TBD			X	X
CE-3 MWA	CE	TBD	TBD	100 - 120	3/4	WT	P	X			X	X
CE-3 MWB	CE	TBD	TBD	140 - 170	5	H	P	X			X	X
CE-3 MWC	CE	TBD	TBD	200 - 250	6	J	P	TBD			X	X
CE-4 MWA	CE	TBD	TBD	100 - 140	4	H	P	X			X	X
CE-5 MWA	CE	TBD	TBD	100 - 120	3/4	WT	P	X			X	X
CE-5 MWB	CE	TBD	TBD	140 - 170	5	H	P	X			X	X
CE-5 MWC	CE	TBD	TBD	200 - 250	6	J	P	TBD			X	X
INJ-1 MWA	PR	TBD	TBD	60 - 120	3	Gs	P		X		X	X
INJ-2 MWA	PR	TBD	TBD	60 - 120	3	Gs	P		X		X	X
INJ-3 MWA	PR	TBD	TBD	60 - 110	3	Gs	P		X		X	X
INJ-4 MWA	PR	TBD	TBD	60 - 100	3	Gs	P		X		X	X

TABLE C-3

EXISTING AND PRE-DESIGN INVESTIGATION WATER LEVEL MONITORING PROGRAM

Well Identifier	AREA	LSE (feet msl)	MPE (feet msl)	Screen Interval (feet bls)	HydroUnit		OBJECTIVES			MONITORING METHOD		
					EPA	DWR	HSU[a]	NE/CE[b,c]	INJ[d]	Early Transducer[1]	PDI Transducer[2]	Periodic Manual[3]
PRE-DESIGN INVESTIGATION MONITOR WELL (continued)												
CINJ-1 MWA	CR	TBD	TBD	100 - 170	3/4	Ga	TBD		TBD		TBD	TBD
CINJ-2 MWA	CR	TBD	TBD	100 - 150	3/4	Ga	TBD		TBD		TBD	TBD
CINJ-3 MWA	CR	TBD	TBD	100 - 110	3/4	Ga	TBD		TBD		TBD	TBD

AREA EXPLANATION

CE Central Extraction Area
CR Contingency Reinjection Area
NE Northern Extraction Area
PR Primary Reinjection Area
RD Remedial Design Work Area
RD* Near RD Work Area

GENERAL

TBD To be determined
msl mean sea level
bls below land surface
EPA U.S. Environmental Protection Agency
DWR California Department of Water Resources
HSU Hydrostratigraphic Unit
LSE Land surface elevation
MPE Measureing point elevation
PDI Pre-Design Investigation

HYDROUNIT EXPLANATION

Gs Gaspur aquifer
Ga Gage aquifer
H Hollydale
J Jefferson aquifer
L Lynwood aquifer
UN Undifferentiated
Y-Z UN Undifferentiated between overlying aquifer (Y) and underling aquifer (Z)
WT Water table (may not be in aquifer)
Deep Below Lynwood aquifer or EPA SB6

OBJECTIVES

[a] Refine the understanding of hydrostratigraphic units
[b] Assist in locating extraction wells
[c] Support development of estimate groundwater extraction rates
[d] Depth to water and flow direction in candidate reinjection area
P or S Primary or secondary

[1] Installed in existing monitor wells during PDI monitor well access, transferred to PDI monitor well after PDI monitor well installed
[2] Monitored throughout PDI from time of PDI monitor well installation to time PDI final groundwater sample collected
[3] Quarterly manual measurements/transducer downloads until PDI final groundwater sample collected

TABLE C-4

EXISTING AND PRE-DESIGN INVESTIGATION GROUNDWATER SAMPLE COLLECTION

Well Identifier	AREA	LSE (feet msl)	MPE (feet msl)	Screen Interval (feet bls)	HydroUnit		OBJECTIVES				SAMPLE EVENT			
					EPA	DWR	NE/CE Target Zone[a]	Reinj[b]	End Use[c]	Treatment[d]	Initial[1]	Confirmation[2]	Periodic[3]	Final[4]
EXISTING														
MW-1A	RD	157.8	157.71	45 - 60	2	Gs							WAMP	
MW-1B	RD	158.1	158.05	75 - 85.4	2, 3	Gs							WAMP	
MW-2	RD	154.2	154.21	45 - 60	2	Gs							WAMP	
MW-3	RD	151.9	151.48	38 - 48	2	UN							WAMP	
MW-4A	RD	147.0	146.80	42.7 - 53	2	Gs							WAMP	
MW-4B	RD	147.0	146.84	69.7 - 80	3	Gs							WAMP	
MW-4C	RD	147.4	147.10	88.7 - 99	3	H							WAMP	
MW-5	RD	150.8	150.60	43.3 - 53.3	2	Gs							WAMP	
MW-6	RD	150.4	150.28	37.1 - 47.5	2	Gs							WAMP	
MW-7	RD	143.6	143.28	35.8 - 46	2, 3	Ga							WAMP	
MW-8A	NE	150.4	150.14	30 - 45	2	Gs	X			TBD			COCs	Mod or Long
MW-8B	NE	150.3	150.03	65 - 75	3	Gs	X			TBD			COCs	Mod or Long
MW-8C	NE	150.3	150.03	86.7 - 91.7	3	Gs	X			TBD			COCs	Mod or Long
MW-8D	NE	150.1	149.91	110 - 120	3, 4	H	X			TBD			COCs	Mod or Long
MW-9A	RD	148.9	148.84	25 - 35	2	Gs							WAMP	
MW-9B	RD	149.1	148.90	49.8 - 60	2	Gs							WAMP	
MW-10	RD	147.4	147.45	52 - 62	3	Ga							WAMP	
MW-11	RD	150.9	150.89	40 - 50	3	Ga							WAMP	
MW-12	RD	220.5	220.87	82 - 97	2, 3	UN							WAMP	
MW-13A	RD	206.3	206.02	56 - 66	2	UN							WAMP	
MW-13B	RD	206.3	205.88	123 - 133	3, 4	UN							WAMP	
MW-14	RD	173.0	172.63	60 - 75	2	Gs								
MW-15	RD	148.7	148.28	50 - 70	2, 3	Gs							WAMP	
MW-16A	RD	153.5	153.19	45 - 60	3	Ga							WAMP	
MW-16B	RD	153.5	153.19	106 - 116	4, 5	H							WAMP	
MW-16C	RD	153.5	153.26	149 - 164	6	J-L UN							WAMP	

TABLE C-4

EXISTING AND PRE-DESIGN INVESTIGATION GROUNDWATER SAMPLE COLLECTION

Well Identifier	AREA	LSE (feet msl)	MPE (feet msl)	Screen Interval (feet bls)	HydroUnit EPA	HydroUnit DWR	OBJECTIVES NE/CE Target Zone[a]	Reinj[b]	End Use[c]	Treatment[d]	SAMPLE EVENT Initial[1]	Confirmation[2]	Periodic[3]	Final[4]
EXISTING (continued)														
MW-17A	RD	159.4	159.03	56 - 71	3	Ga, H							WAMP	
MW-17B	RD	159.4	158.90	94 - 104	4	H							WAMP	
MW-17C	RD	159.4	159.00	172 - 182	6	L							WAMP	
MW-18A	NE	144.3	143.73	56 - 71	3, 4	H	X			TBD			COCs	Mod or Long
MW-18B	NE	144.3	143.83	90 - 100	5	H-J UN	X			TBD			COCs	Mod or Long
MW-18C	NE	144.3	143.83	146 - 161	6	J-L UN	X			TBD			COCs	Mod or Long
MW-19	RD	159.0	158.73	56 - 71	3	Ga							WAMP	
MW-20A	CE	142.1	141.31	75 - 90	3	Ga	X			TBD			COCs	Mod or Long
MW-20B	CE	142.1	141.32	122 - 132	4	H	X			TBD			COCs	Mod or Long
MW-20C	CE	142.1	141.35	180 - 190	6	J	X			TBD			COCs	Mod or Long
MW-21	RD	129.3	128.81	64 - 79	3	Gs							WAMP	
MW-22	RD	151.5	150.82	74 - 89	3	Ga-H UN							WAMP	
MW-23A	NE	149.1	148.76	35 - 55	2	Gs	X			TBD			COCs	Mod or Long
MW-23B	NE	149.4	149.06	82 - 97	3	Gs	X			TBD			COCs	Mod or Long
MW-23C	NE	149.4	149.07	145 - 160	5	J	X			TBD			COCs	Mod or Long
MW-23D	NE	149.4	148.04	175 - 185	6	J-L UN	X			TBD			COCs	Mod or Long
MW-24A	RD	162.4	162.04	50 - 70	2	Gs							WAMP	
MW-24B	RD	162.4	162.03	110 - 125	3	Ga-H UN							WAMP	
MW-24C	RD	162.4	162.02	140 - 160	4, 5	J							WAMP	
MW-24D	RD	162.4	162.05	173 - 178	6	L							WAMP	
MW-25A	NE	148.3	147.90	45 - 65	3	Ga	X			TBD			COCs	Mod or Long
MW-25B	NE	148.3	147.84	90 - 110	4, 5	H	X			TBD			COCs	Mod or Long
MW-25C	NE	148.3	147.86	140 - 150	6	J-L UN	X			TBD			COCs	Mod or Long
MW-25D	NE	148.3	147.87	194 - 209	Deep	L	X			TBD			COCs	Mod or Long

TABLE C-4

EXISTING AND PRE-DESIGN INVESTIGATION GROUNDWATER SAMPLE COLLECTION

Well Identifier	AREA	LSE (feet msl)	MPE (feet msl)	Screen Interval (feet bls)	HydroUnit EPA	HydroUnit DWR	OBJECTIVES NE/CE Target Zone[a]	Reinj[b]	End Use[c]	Treatment[d]	SAMPLE EVENT Initial[1]	Confirmation[2]	Periodic[3]	Final[4]
EXISTING (continued)														
MW-26A	RD	156.0	155.62	70 - 90	3	H							WAMP	
MW-26B	RD	156.0	155.45	105 - 120	4	H							WAMP	
MW-26C	RD	156.0	155.41	145 - 160	6	J							WAMP	
MW-26D	RD	156.0	155.37	185 - 205	6	L							WAMP	
MW-27A		139.5	139.24	90 - 110	3	Ga							WAMP	
MW-27B		139.5	139.18	144 - 164	4	H							WAMP	
MW-27C		139.5	139.17	180 - 190	5	H							WAMP	
MW-27D		139.5	139.13	200 - 210	5, 6	H-J UN							WAMP	
MW-31	RD	233.0	232.67	106 - 121	3	UN							WAMP	
SFS_Hawkins_1a_	RD	147.8	147.40	480 - 490	Deep	Deep							WAMP	
SFS_Hawkins_1b_	RD	147.8	147.30	378 - 388	Deep	Deep							WAMP	
SFS_Hawkins_1c_	CE	147.8	147.19	286 - 296	Deep	L	X			TBD			COCs	Mod or Long
SFS_Hawkins_1c_	CE	147.8	147.18	242 - 252	6	J-L UN	X			TBD			COCs	Mod or Long
SFS_Hawkins_1c_	CE	147.8	147.20	168 - 178	5	H-J UN	X			TBD			COCs	Mod or Long
PRE-DESIGN INVESTIGATION MONITOR WELL														
NE-1 MWA	NE	TBD	TBD	50 - 100	2/3	Gs	X			TBD	COCs	Mod List	COCs	Mod or Long
NE-1 MWB	NE	TBD	TBD	120 - 150	3	H	X			TBD	COCs	Mod List	COCs	Mod or Long
NE-1 MWC	NE	TBD	TBD	160 - 180	4	J	X			TBD	COCs	Mod List	COCs	Mod or Long
NE-1 MWD	NE	TBD	TBD	200 - 250	5/6	L	X			TBD	COCs	Mod List	COCs	Mod or Long
NE-2 MWA	NE	TBD	TBD	50 - 90	2	Gs	X			TBD	COCs	Mod List	COCs	Mod or Long
NE-2 MWB	NE	TBD	TBD	100 - 120	3	H	X			TBD	COCs	Mod List	COCs	Mod or Long
NE-2 MWC	NE	TBD	TBD	130 - 150	4	J	X			TBD	COCs	Mod List	COCs	Mod or Long
NE-2 MWD	NE	TBD	TBD	200 - 250	5/6	L	X			TBD	COCs	Mod List	COCs	Mod or Long

TABLE C-4

EXISTING AND PRE-DESIGN INVESTIGATION GROUNDWATER SAMPLE COLLECTION

Well Identifier	AREA	LSE (feet msl)	MPE (feet msl)	Screen Interval (feet bls)	HydroUnit EPA	HydroUnit DWR	OBJECTIVES NE/CE Target Zone[a]	OBJECTIVES Reinj[b]	OBJECTIVES End Use[c]	OBJECTIVES Treatment[d]	SAMPLE EVENT Initial[1]	SAMPLE EVENT Confirmation[2]	SAMPLE EVENT Periodic[3]	SAMPLE EVENT Final[4]
PRE-DESIGN INVESTIGATION MONITOR WELL (continued)														
NE-3 MWA	NE	TBD	TBD	50 - 70	2	Ga	X			TBD	COCs	Mod List	COCs	Mod or Long
NE-3 MWB	NE	TBD	TBD	80 - 100	3	H	X			TBD	COCs	Mod List	COCs	Mod or Long
NE-3 MWC	NE	TBD	TBD	120 - 140	4	J	X			TBD	COCs	Mod List	COCs	Mod or Long
CE-1 MWA	CE	TBD	TBD	100 - 120	3/4	WT	X			TBD	COCs	Mod List	COCs	Mod or Long
CE-1 MWB	CE	TBD	TBD	140 - 170	4	H	X			TBD	COCs	Mod List	COCs	Mod or Long
CE-1 MWC	CE	TBD	TBD	200 - 250	5/6	J	X			TBD	COCs	Mod List	COCs	Mod or Long
CE-2 MWA	CE	TBD	TBD	100 - 120	3/4	WT	X			TBD	COCs	Mod List	COCs	Mod or Long
CE-2 MWB	CE	TBD	TBD	140 - 170	4	H	X			TBD	COCs	Mod List	COCs	Mod or Long
CE-2 MWC	CE	TBD	TBD	200 - 250	5/6	J	X			TBD	COCs	Mod List	COCs	Mod or Long
CE-3 MWA	CE	TBD	TBD	100 - 120	3/4	WT	X			TBD	COCs	Mod List	COCs	Mod or Long
CE-3 MWB	CE	TBD	TBD	140 - 170	5	H	X			TBD	COCs	Mod List	COCs	Mod or Long
CE-3 MWC	CE	TBD	TBD	200 - 250	6	J	X			TBD	COCs	Mod List	COCs	Mod or Long
CE-4 MWA	CE	TBD	TBD	100 - 140	4	H	X			TBD	COCs	Mod List	COCs	Mod or Long
CE-5 MWA	CE	TBD	TBD	100 - 120	3/4	WT	X			TBD	COCs	Mod List	COCs	Mod or Long
CE-5 MWB	CE	TBD	TBD	140 - 170	5	H	X			TBD	COCs	Mod List	COCs	Mod or Long
CE-5 MWC	CE	TBD	TBD	200 - 250	6	J	X			TBD	COCs	Mod List	COCs	Mod or Long
INJ-1 MWA	PR	TBD	TBD	60 - 120	3	Gs		X	X	X	Mod	Long	COCs	COCs
INJ-2 MWA	PR	TBD	TBD	60 - 120	3	Gs		X	X	X	Mod	Long	COCs	COCs
INJ-3 MWA	PR	TBD	TBD	60 - 110	3	Gs		X	X	X	Mod	Long	COCs	COCs
INJ-4 MWA	PR	TBD	TBD	60 - 100	3	Gs		X	X	X	Mod	Long	COCs	COCs

TABLE C-4

EXISTING AND PRE-DESIGN INVESTIGATION GROUNDWATER SAMPLE COLLECTION

Well Identifier	AREA	LSE (feet msl)	MPE (feet msl)	Screen Interval (feet bls)	HydroUnit EPA	HydroUnit DWR	OBJECTIVES NE/CE Target Zone[a]	Reinj[b]	End Use[c]	Treatment[d]	SAMPLE EVENT Initial[1]	Confirmation[2]	Periodic[3]	Final[4]
PRE-DESIGN INVESTIGATION MONITOR WELL (continued)														
CINJ-1 MWA	CR	TBD	TBD	100 - 170	3/4	Ga		TBD	TBD	TBD	TBD	TBD	TBD	TBD
CINJ-2 MWA	CR	TBD	TBD	100 - 150	3/4	Ga		TBD	TBD	TBD	TBD	TBD	TBD	TBD
CINJ-3 MWA	CR	TBD	TBD	100 - 110	3/4	Ga		TBD	TBD	TBD	TBD	TBD	TBD	TBD

AREA EXPLANATION

CE Central Extraction Area
CR Contingency Reinjection Area
NE Northern Extraction Area
PR Primary Reinjection Area
RD Remedial Design Work Area

GENERAL

TBD To be determined
msl mean sea level
bls below land surface
EPA U.S. Environmental Protection Agency
DWR California Department of Water Resources
LSE Land surface elevation
MPE Measureing point elevation
PDI Pre-Design Investigation
WAMP Work Area Monitoring Program
COC Chemical of concern

Mod COCs; Key Treatment Constituents; general chemistry; treatment system design; and emergent compounds
Mod or Long Long (mod + permitting constituents) conducted on 6 NE and 6 CE wells, others Mod

HYDROUNIT EXPLANATION

Gs Gaspur aquifer
Ga Gage aquifer
H Hollydale
J Jefferson aquifer
L Lynwood aquifer
UN Undifferentiated
Y-Z UN Undifferentiated between overlying aquifer (Y) and underling aquifer (Z)
WT Water table (may not be in aquifer)
Deep Below Lynwood aquifer or EPA SB6

OBJECTIVES

[a] Define the areas and depths targeted for hydraulic control in the NE and CE Areas
[b] Determine if reinjection is viable, and if so, define areas and depths of reinjection
[c] Support evaluation of end use(s) of treated groundwater
[d] Design treatment system

[1] Collected within approximately 2 to 4 weeks of well development
[2] Collected within approximately 6 weeks of initial sample collection
[3] Starting the quarter after in the initial PDI monitor well is installed to the quarter the last PDI monitor well installed
[4] Conducted after final PDI monitor well has been installed/initial sample collected, contemporaneous event

TABLE C-5

PRE-DESIGN INVESTIGATION EXPLORATORY BOREHOLE AND MONITOR WELL SUMMARY

LOCATION	ID	FEATURE	TARGET INTERVAL	HYDROSTRATIGRAPHIC UNITS	DECISION CRITERIA FOR ADDITIONAL INVESTIGATION
Slauson Avenue west side of OU2	NE-1 EB	Exploratory Borehole	Through bottom of Lynwood / EPA SB6 (375 feet, bottom of EPA SB6 deeper than bottom of Lynwood)	B104: Gaspur (Gage may be merged with Gaspur or eroded off); Hollydale; Jefferson and Lynwood aquifers EPA: SB2 to SB6	No additional exploratory boreholes to east as existing/new monitor well coverage is adequate, no additional investigation to west given proximity of western edge of OU2. Potential deeper exploratory boring installation if deepest monitor well average COC concentration exceeds MCL (or NL for 1,4-dioxane) and existing lithologic information from original exploratory borehole not deep enough to design deeper monitor well.
	NE-1 MWA	Monitor Well	Gaspur Aquifer (may be merged with Gage): first shallow aquifer near water table (50 to 100 feet)	B104: Gaspur aquifer EPA: SB2/Upper portion of SB3	No additional monitor wells to east as additional coverage with new/existing wells is adequate, no additional investigation to west given proximity of western edge of OU2. No additional deeper monitor wells as new Hollydale monitor well in cluster provides vertical control.
	NE-1 MWB	Monitor Well	Hollydale Aquifer: next aquifer beneath Gaspur (120 to 150 feet)	B104: Hollydale aquifer EPA: SB3	No additional monitor wells to east as additional coverage with new/existing wells is adequate, no additional investigation to west given proximity of western edge of OU2. No additional deeper monitor wells as new Jefferson monitor well in cluster provides vertical control.
	NE-1 MWC	Monitor Well	Jefferson Aquifer: next aquifer beneath Hollydale (160 to 180 feet)	B104: Jefferson aquifer EPA: SB4	No additional monitor wells to east as additional coverage with new/existing wells is adequate, no additional investigation to west given proximity of western edge of OU2. No additional deeper monitor wells as new Lynwood monitor well in cluster provides vertical control.
	NE-1 MWD	Monitor Well	Lynwood Aquifer: next aquifer beneath Jefferson (may be as deep as 200 to 250, could be shallower). This is one of two Lynwood monitor wells designed to assess vertical extent of COCs in vicinity of EPA monitor well MW-23D	B104: Lynwood aquifer EPA: SB5/Upper portion of SB6	No additional monitor wells to east as additional coverage with new/existing wells is adequate, no additional investigation to west given proximity of western edge of OU2. Potential contingency deeper monitor well in deeper interval(s) if average of Lynwood monitor well results for COCs exceeds MCL (or NL in case of 1,4-dioxane). If deeper contingency monitor well(s) indicates average concentrations of COCs exceeds MCL (or NL in case of 1,4-dioxane), additional contingency deeper monitor wells may be required vertically.
Sorensen Avenue near Baker Place	NE-2 EB	Exploratory Borehole	Through bottom of Lynwood / EPA SB6 (375 feet, bottom of EPA SB6 deeper than bottom of Lynwood)	B104: Gaspur (Gage may be merged with Gaspur or eroded off); Hollydale; Jefferson and Lynwood aquifers EPA: SB2 to SB6	No additional exploratory boreholes to east or west as the coverage with existing/new wells is adequate. Potential deeper exploratory boring installation if deepest monitor well average COC concentration exceeds MCL or NL and existing lithologic information from original exploratory borehole not deep enough to design deeper monitor well.
	NE-2 MWA	Monitor Well	Gaspur Aquifer (may be merged with Gage): first shallow aquifer near water table (50 to 90 feet)	B104: Gaspur aquifer EPA: SB2	No additional monitor wells to east or west as additional coverage with new/existing wells is adequate. No additional deeper monitor wells as new Hollydale monitor well in cluster provides vertical control.
	NE-2 MWB	Monitor Well	Hollydale Aquifer: next aquifer beneath Gaspur (100 to 120 feet)	B104: Hollydale aquifer EPA: SB3	No additional monitor wells to east or west as additional coverage with new/existing wells is adequate. No additional deeper monitor wells as new Jefferson monitor well in cluster provides vertical control.
	NE-2 MWC	Monitor Well	Jefferson Aquifer: next aquifer beneath Hollydale (130 to 150 feet)	B104: Jefferson aquifer EPA: SB4	No additional monitor wells to east or west as additional coverage with new/existing wells is adequate. No additional deeper monitor wells as new Lynwood monitor well in cluster provides vertical control.
	NE-2 MWD	Monitor Well	Lynwood Aquifer: next aquifer beneath Jefferson (may be as deep as 200 to 250, could be shallower). This is one of two Lynwood monitor wells designed to assess vertical extent of COCs in vicinity of EPA monitor well MW-23D	B104: Lynwood aquifer EPA: SB5/Upper portion of SB6	No additional monitor wells to east or west as additional coverage with new/existing wells is adequate. Potential contingency deeper monitor well in deeper interval(s) if average of Lynwood monitor well results for COCs exceeds MCL or NL. If deeper contingency monitor well(s) indicates concentrations of COCs exceeds MCL or NL, additional contingency deeper monitor wells may be required vertically.

TABLE C-5

PRE-DESIGN INVESTIGATION EXPLORATORY BOREHOLE AND MONITOR WELL SUMMARY

LOCATION	ID	FEATURE	TARGET INTERVAL	HYDROSTRATIGRAPHIC UNITS	DECISION CRITERIA FOR ADDITIONAL INVESTIGATION
Sorensen Avenue to west of John Street	NE-3 EB	Exploratory Borehole	Through bottom of Lynwood / EPA SB6 (300 feet, bottom of EPA SB6 deeper than bottom of Lynwood)	B104: Gage; Hollydale; Jefferson and Lynwood aquifers (Gaspur not present or unsaturated) EPA: SB2 to SB6	No additional exploratory boreholes to east or west as the coverage with existing/new wells is adequate. Potential deeper exploratory boring installation if deepest monitor well average COC concentration exceeds MCL or NL and existing lithologic information from original exploratory borehole not deep enough to design deeper monitor well.
	NE-3 MWA	Monitor Well	Gage Aquifer: first shallow aquifer near water table (50 to 70 feet)	B104: Gage aquifer EPA: SB2	No additional monitor wells to east or west as additional coverage with new/existing wells is adequate. No additional deeper monitor wells as new Hollydale monitor well in cluster provides vertical control.
	NE-3 MWB	Monitor Well	Hollydale Aquifer: next aquifer beneath Gage (80 to 100 feet)	B104: Hollydale aquifer EPA: SB3	No additional monitor wells to east or west as additional coverage with new/existing wells is adequate. No additional deeper monitor wells as new Jefferson monitor well in cluster provides vertical control.
	NE-3 MWC	Monitor Well	Jefferson Aquifer: next aquifer beneath Hollydale (120 to 140 feet)	B104: Jefferson aquifer EPA: SB4	No additional monitor wells to east or west as additional coverage with new/existing wells is adequate. Potential contingency deeper monitor well in Lynwood if average of Jefferson monitor well results for COCs exceeds MCL or NL. If deeper contingency monitor well(s) indicates concentrations of COCs exceeds MCL or NL, additional contingency deeper monitor wells may be required vertically.
Telegraph Road on west side of OU2	CE-1 EB	Exploratory Borehole	Through bottom of Lynwood / EPA SB6 (425 feet, bottom of EPA SB6 deeper than bottom of Lynwood)	B104: Gage (may be unsaturated); Hollydale; Jefferson and Lynwood aquifers (Gaspur not unsaturated; Artesia not present) EPA: SB3 to SB6	No additional exploratory boreholes to east as the coverage with existing/new wells is adequate, no additional investigation to west given proximity of western edge of OU2. Potential deeper exploratory boring installation if deepest monitor well average COC concentration exceeds MCL or NL and existing lithologic information from original exploratory borehole not deep enough to design deeper monitor well.
	CE-1 MWA	Monitor Well	Water table beneath Gage Aquifer (Gage Aquifer likely unsaturated) (100 to 120 feet)	B104: Between Gage and Hollydale (water table) EPA: SB3/SB4 (SB3 may be unsaturated)	No additional monitor wells to east as additional coverage with new/existing wells is adequate, no additional investigation to west given proximity of western edge OU2. No additional deeper monitor wells as new Hollydale monitor well in cluster provides vertical control.
	CE-1 MWB	Monitor Well	Hollydale Aquifer: next aquifer beneath Gage (140 to 170 feet)	B104: Hollydale aquifer EPA: SB4	No additional monitor wells to east as additional coverage with new/existing wells is adequate, no additional investigation to west given proximity of western edge of OU2. No additional deeper monitor wells as new Jefferson monitor well in cluster provides vertical control.
	CE-1 MWC	Monitor Well	Jefferson Aquifer: next aquifer beneath Hollydale (200 to 250 feet)	B104: Jefferson aquifer EPA: SB5/Upper portion of SB6	No additional monitor wells to east as additional coverage with new/existing wells is adequate, no additional investigation to west given proximity of western edge OU2. Potential contingency deeper monitor well in Lynwood if average of Jefferson monitor well results for COCs exceeds MCL or NL. If deeper contingency monitor well(s) indicates concentrations of COCs exceeds MCL or NL, additional contingency deeper monitor wells may be required vertically.

TABLE C-5

PRE-DESIGN INVESTIGATION EXPLORATORY BOREHOLE AND MONITOR WELL SUMMARY

LOCATION	ID	FEATURE	TARGET INTERVAL	HYDROSTRATIGRAPHIC UNITS	DECISION CRITERIA FOR ADDITIONAL INVESTIGATION
Telegraph Road to west of Matern Place	CE-2 EB	Exploratory Borehole	Through bottom of Lynwood / EPA SB6 (400 feet, bottom of EPA SB6 deeper than bottom of Lynwood)	B104: Gage (may be unsaturated); Hollydale; Jefferson and Lynwood aquifers (Gaspur not unsaturated; Artesia not present) EPA: SB3 to SB6	No additional exploratory boreholes to east or west as the coverage with existing/new wells is adequate. Potential deeper exploratory boring installation if deepest monitor well average COC concentration exceeds MCL or NL and existing lithologic information from original exploratory borehole not deep enough to design deeper monitor well.
	CE-2 MWA	Monitor Well	Water table beneath Gage Aquifer (Gage Aquifer likely unsaturated) (100 to 120 feet)	B104: Between Gage and Hollydale (water table) EPA: SB3/SB4 (SB3 may be unsaturated)	No additional monitor wells to east or west as the coverage with existing/new wells is adequate. No additional deeper monitor wells as new Hollydale monitor well in cluster provides vertical control.
	CE-2 MWB	Monitor Well	Hollydale Aquifer: next aquifer beneath Gage (140 to 170 feet)	B104: Hollydale aquifer EPA: SB4	No additional monitor wells to east or west as the coverage with existing/new wells is adequate. No additional deeper monitor wells as new Jefferson monitor well in cluster provides vertical control.
	CE-2 MWC	Monitor Well	Jefferson Aquifer: next aquifer beneath Hollydale (200 to 250 feet)	B104: Jefferson aquifer EPA: SB5/Upper portion of SB6	No additional monitor wells to east or west as the coverage with existing/new wells is adequate. Potential contingency deeper monitor well in Lynwood if average of Jefferson monitor well results for COCs exceeds MCL or NL. If deeper contingency monitor well(s) indicates concentrations of COCs exceeds MCL or NL, additional contingency deeper monitor wells may be required vertically.
Telegraph Road near Matern Place	CE-3 EB	Exploratory Borehole	Through bottom of Lynwood / EPA SB6 (375 feet, bottom of EPA SB6 deeper than bottom of Lynwood)	B104: Gage (may be unsaturated); Hollydale; Jefferson and Lynwood aquifers (Gaspur and/or Artesia not present or unsaturated) EPA: SB3 to SB6	No additional exploratory boreholes to east or west as the coverage with existing/new wells is adequate. Potential deeper exploratory boring installation if deepest monitor well average COC concentration exceeds MCL or NL and existing lithologic information from original exploratory borehole not deep enough to design deeper monitor well.
	CE-3 MWA	Monitor Well	Water table beneath Gage Aquifer (Gage Aquifer likely unsaturated) (100 to 120 feet)	B104: Between Gage and Hollydale (water table) EPA: SB3/SB4 (SB3 may be unsaturated)	No additional exploratory boreholes to east or west as the coverage with existing/new wells is adequate. No additional deeper monitor wells as new Hollydale monitor well in cluster provides vertical control.
	CE-3 MWB	Monitor Well	Hollydale Aquifer: next aquifer beneath Gage (140 to 170 feet)	B104: Hollydale aquifer EPA: SB5	No additional exploratory boreholes to east or west as the coverage with existing/new wells is adequate. No additional deeper monitor wells as new Jefferson monitor well in cluster provides vertical control.
	CE-3 MWC	Monitor Well	Jefferson Aquifer: next aquifer beneath Hollydale (200 to 250 feet)	B104: Jefferson aquifer EPA: SB6	No additional exploratory boreholes to east or west as the coverage with existing/new wells is adequate. Potential contingency deeper monitor well in Lynwood if average of Jefferson monitor well results for COCs exceeds MCL or NL. If deeper contingency monitor well(s) indicates concentrations of COCs exceeds MCL or NL, additional contingency deeper monitor wells may be required vertically.
Near Hawkins Well Cluster	CE-4 MWA	Monitor Well	Water table to Hollydale (100 to 140 feet)	B104: Hollydale EPA: SB4	No additional monitor wells to east or west as the coverage with existing/new wells is adequate. No additional deeper monitor wells as deeper well in Hawkins cluster provides vertical control.

TABLE C-5

PRE-DESIGN INVESTIGATION EXPLORATORY BOREHOLE AND MONITOR WELL SUMMARY

LOCATION	ID	FEATURE	TARGET INTERVAL	HYDROSTRATIGRAPHIC UNITS	DECISION CRITERIA FOR ADDITIONAL INVESTIGATION
Telegraph Road east side of OU2	CE-5 EB	Exploratory Borehole	Through bottom of Lynwood / EPA SB6 (350 feet, bottom of Lynwood deeper than bottom of EPA SB6)	B104: Gage (may be unsaturated); Hollydale; Jefferson and Lynwood aquifers (Gaspur not present and Artesia not unsaturated) EPA: SB3 to SB6	No additional exploratory boreholes to west as the coverage with existing/new wells is adequate, no additional investigation to east given proximity of eastern edge of OU2. Potential deeper exploratory boring installation if deepest monitor well average COC concentration exceeds MCL or NL and existing lithologic information from original exploratory borehole not deep enough to design deeper monitor well.
	CE-5 MWA	Monitor Well	Water table beneath Gage Aquifer (Gage Aquifer likely unsaturated) (100 to 120 feet)	B104: Between Gage and Hollydale (water table) EPA: SB3/SB4	No additional monitor wells to west as additional coverage with new/existing wells is adequate, no additional investigation to east given proximity of eastern edge of OU2. No additional deeper monitor wells as new Hollydale monitor well in cluster provides vertical control.
	CE-5 MWB	Monitor Well	Hollydale Aquifer: next aquifer beneath Gage (140 to 170 feet)	B104: Hollydale aquifer EPA: SB5	No additional monitor wells to west as additional coverage with new/existing wells is adequate, no additional investigation to east given proximity of eastern edge of OU2. No additional deeper monitor wells as new Jefferson monitor well in cluster provides vertical control.
	CE-5 MWC	Monitor Well	Jefferson Aquifer: next aquifer beneath Hollydale (200 to 250 feet)	B104: Jefferson aquifer EPA: SB6	No additional monitor wells to west as additional coverage with new/existing wells is adequate, no additional investigation to east given proximity of eastern edge of OU2. Potential contingency deeper monitor well in Lynwood if average of Jefferson monitor well results for COCs exceeds MCL or NL. If deeper contingency monitor well(s) indicates concentrations of COCs exceeds MCL or NL, additional contingency deeper monitor wells may be required vertically.
Riveria Road west of Duchess Dr	INJ-1 MWA	Monitor Well	Through bottom of Gaspur (60 to 120 feet)	B104: Gaspur EPA: SB3	No additional monitor wells in area. May add pilot injection well in vicinity of one of these monitor wells if initial hydraulic test and water quality data indicate this injection area is a potential candidate area, if this is the case the pilot injection well would be installed in the vicinity of the monitor well with the lowest hydraulic conductivity/transmissivity (INJ-1 to INJ-4). May need to evaluate contingency reinjection area if water quality data or hydraulic data do not support reinjection in this general area.
Slauson Avenue and Norwalk Avenue	INJ-2 MWA	Monitor Well	Through bottom of Gaspur (60 to 120 feet)	B104: Gaspur EPA: SB3	
Aeolian St and Westman Ave	INJ-3 MWA	Monitor Well	Through bottom of Gaspur (60 to 110 feet)	B104: Gaspur EPA: SB3	
Allport Ave and Washington Blvd	INJ-4 MWA	Monitor Well	Through bottom of Gaspur (60 to 100 feet)	B104: Gaspur EPA: SB3	
Alburtis Ave and Dunning St	CINJ-1 MWA	Monitor Well	Through bottom of Gage (100 to 170 feet)	B104: Gage EPA: SB3/SB4	Not planning on installing monitor wells in this area unless testing at INJ-1 to INJ-4 indicates that area is not suitable for injection and reinjection is not screened for further consideration. May add pilot injection well in vicinity of one of these monitor wells if initial hydraulic test and water quality data indicate this injection area is a potential candidate area, if this is the case the pilot injection well would be installed in the vicinity of the monitor well with the lowest hydraulic conductivity/transmissivity (CINJ-1 to CINJ-3). May need to evaluate alternate contingency reinjection area (not identified at this time) if water quality data or hydraulic data do not support reinjection in this general area.
Alburtis Ave and Telegraph Road	CINJ-2 MWA	Monitor Well	Through bottom of Gage (100 to 150 feet)	B104: Gage EPA: SB3/SB4	
Alburtis Ave and Pioneer Blvd	CINJ-3 MWA	Monitor Well	Through bottom of Gage (100 to 110 feet)	B104: Gage EPA: SB3/SB4	

OU2 Operable Unit 2 as defined in 2011 Record of Decision
COC Chemical of Concern
NL Notification Level
MCL Maximum Contaminant Level
EB Exploratory borehole

TABLE C-6
GROUNDWATER ANALYTE LISTS

Constituent Group	Analyte Group	Compound/Constituent	CAS	OBJECTIVES: NE/CE Target Zones[1]	OBJECTIVES: Treated Water End Use Evaluation[2]	OBJECTIVES: Treatment System Design[3]	SAMPLE GROUP
COCs	VOCs (Main COCs and/or RI COPCs)	Trichloroethylene (TCE)	79-01-6				COCs, Moderate List, and Long List
		Tetrachloroethylene (PCE)	127-18-4				
		Trichlorofluoromethane (FREON 11)	75-69-4				
		Trichlorotrifluoroethane (FREON 113)	76-13-1				
		1,1-Dichloroethylene (1,1-DCE)	75-35-4				
		cis-1,2-Dichloroethylene (c-1,2-DCE)	156-59-2				
		Chloroform (Trichloromethane)	67-66-3				
		Carbon tetrachloride	56-23-5				
		1,1-Dichloroethane (1,1-DCA)	75-34-3				
		1,2-Dichloroethane (1,2-DCA)	107-06-2				
		1,1,1-Trichloroethane (1,1,1-TCA)	71-55-6				
		1,1,2,2-Tetrachloroethane	79-34-5				
		Dibromochloropropane (DBCP) [c]	96-12-6				
		Ethylene Dibromide (EDB) [c]	106-93-4				
		Benzene	71-43-2				
		Carbon disulfide [d]	75-15-0				
		Monochlorobenzene (Chlorobenzene)	108-90-7				
		cis-1,3-Dichloropropene	10061-01-5				
		Methyl tert-Butyl Ether (MTBE)	1634-04-4				
		Dichloromethane (Methylene Chloride) [d]	75-09-2				
		Toluene	108-88-3				
		trans-1,2-Dichloroethylene (t-1,2-DCE)	156-60-5				
		trans-1,3-dichloropropene	10061-02-6				
		Vinyl Chloride (VC)	75-01-4				
	Emergent Compounds	1,4-Dioxane	123-91-1				
		Chromium, hexavalent (CrVI)	18540-29-9				
Key Treatment Constituents	SVOCs	Bis (2-Ethylhexyl)phthalate	117-81-7				Moderate List and Long List
	General Mineral	Aluminum (Al)	7429-90-5				
		Manganese (Mn)	7439-96-5				
		Selenium (Se)	7782-49-2				
		Chromium (Total Cr)	7440-47-3				
		Sulfate (SO4)	14808-79-8				
		Nitrate as Nitrogen (N)	14797-55-8				
		Total Dissolved Solids (TDS)	10-33-3				
	Emergent Compounds	Perchlorate	14797-73-0				

TABLE C-6
GROUNDWATER ANALYTE LISTS

Constituent Group	Analyte Group	Compound/Constituent	CAS	OBJECTIVES: NE/CE Target Zones[1]	OBJECTIVES: Treated Water End Use Evaluation[2]	OBJECTIVES: Treatment System Design[3]	SAMPLE GROUP
General Chemistry[a]	General Mineral	Antimony	7440-36-0				Moderate List and Long List (continued)
		Arsenic	7440-38-2				
		Barium (Ba)	7440-39-3				
		Beryllium	7440-41-7				
		Cadmium (Cd)	7440-43-9				
		Cobalt	7440-48-4				
		Copper (Cu)	7440-50-8				
		Iron (Fe)	7439-89-6				
		Lead (Pb)	7439-92-1				
		Molybdenum	7439-98-7				
		Mercury (Hg)	7439-97-6				
		Nickel	7440-02-0				
		Silver (Ag)	7440-22-4				
		Thallium	7440-28-0				
		Vanadium	7440-62-2				
		Zinc (Zn)	7440-66-6				
		Chloride	16887-00-6				
		Alkalinity, (Total) (as CaCO3 equivalents)	TOT-ALK				
		Bicarbonate (as HCO3)	71-52-3				
		Calcium (Ca)	7440-70-2				
		Sodium (Na)					
		Potassium (K)	7440-09-7				
		Magnesium (Mg)	7439-95-4				
		Fluoride (F) (Natural-Source)	16984-48-8				
		Boron	7440-42-8				
		Silica	7631-86-9				
		Phosphate (as PO4)	PO4				
		Ammonia	NH3				
Treatment System[a]	General Mineral	Uranium	7440-61-1				
		Strontium	7440-24-6				
Emergent Compounds[a]		n-Nitrosodimethylamine (NDMA)	10595-95-6				
		1,2,3-Trichloropropane	96-18-4				

TABLE C-6
GROUNDWATER ANALYTE LISTS

Constituent Group	Analyte Group	Compound/Constituent	CAS	OBJECTIVES: NE/CE Target Zones[1]	OBJECTIVES: Treated Water End Use Evaluation[2]	OBJECTIVES: Treatment System Design[3]	SAMPLE GROUP
Other Permitting[a]	VOCs	1,1,2-Trichloroethane (1,1,2-TCA)	79-00-5				Long List
		1,2-Dichlorobenzene (o-DCB)	95-50-1				
		1,2-Dichloropropane	78-87-5				
		1,3-Dichlorobenzene (m-DCB)	541-73-1				
		1,3-Dichloropropene, Total	542-75-6				
		1,4-Dichlorobenzene (p-DCB)	106-46-7				
		2-Chloroethylvinyl Ether	110-75-8				
		Acetone	67-64-1				
		Acrolein	107-02-8				
		Acrylonitrile (Acritet)	107-13-1				
		Bromoform	75-25-2				
		Dibromochloromethane	124-48-1				
		Chloroethane	75-00-3				
		Bromodichloromethane	75-27-4				
		Ethyl Benzene	100-41-4				
		Bromomethane (Methyl Bromide)	74-83-9				
		Chloromethane (Methyl Chloride)	74-87-3				
		Diisopropyl Ether (DIPE)	108-20-3				
		Methyl Ethyl Ketone (MEK, Butanone)	78-93-3				
		tert-Amyl Methyl Ether (TAME)	994-05-8				
		tert-Butyl Alcohol (TBA)	75-65-0				
		Styrene	100-42-5				
		m,p-Xylene	179601-23-1				
		Total Xylenes (m,p, & o)	1330-20-7				
	General Mineral	Asbestos	1332-21-4				
		Chemical oxygen demand	--				
		pH	12408-02-5				
		Oxidation-reduction potential	--				
		Dissolved oxygen	--				
		Carbon Dioxide	124-38-9				
		Nitrate + Nitrite as Nitrogen (N)	NO3NO2				
		Combined Radium-226 and Radium-228	7440-14-4				
		Gross Alpha	12587-46-1				
		Tritium	10028-17-8				
		Strontium – 90	10098-97-2				
		Gross Beta	12587-47-2				
		Uranium	7440-61-1				

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TABLE C-6
GROUNDWATER ANALYTE LISTS

Constituent Group	Analyte Group	Compound/Constituent	CAS	OBJECTIVES: NE/CE Target Zones[1]	OBJECTIVES: Treated Water End Use Evaluation[2]	OBJECTIVES: Treatment System Design[3]	SAMPLE GROUP
Other Permitting (continued)[a]	Misc	Total petroleum hydrocarbons	--				Long List (continued)
		Biochemical oxygen demand	--				
		Methane	74-82-8				
		Temperature	--				
		Coliform[f]	--				
		Ethanol	64-17-5				
		Methanol	67-56-1				
		Cyanide	57-12-5				
		2,3,7,8-TCDD (Dioxin)	1746-01-6				
	Pesticides and PCBs	4,4'-DDD	72-54-8				
		4,4'-DDE	72-55-9				
		4,4'-DDT	50-29-3				
		Endosulfan I	959-98-8				
		alpha-BHC	319-84-6				
		Aldrin	309-00-2				
		Endosulfan II	33213-65-9				
		beta-BHC	319-85-7				
		Chlordane	57-74-9				
		delta-BHC	319-86-8				
		Dieldrin	60-57-1				
		Endosulfan Sulfate	1031-07-8				
		Endrin	72-20-8				
		Endrin Aldehyde	7421-93-4				
		Heptachlor	76-44-8				
		Heptachlor Epoxide	1024-57-3				
		gamma-BHC	58-89-9				
		PCB-1016 (as decachlorobiphenyl (DCB))	12674-11-2				
		PCB-1221 (as DCB)	11104-28-2				
		PCB-1232 (as DCB)	11141-16-5				
		PCB-1242 (as DCB)	53469-21-9				
		PCB-1248 (as DCB)	12672-29-6				
		PCB-1254 (as DCB)	11097-69-1				
		PCB-1260 (as DCB)	11096-82-5				
		Toxaphene	8001-35-2				
	SVOCs	1,2-Diphenylhydrazine	122-66-7				
		1,2,4-Trichlorobenzene	120-82-1				
		2-Chlorophenol	95-57-8				
		2,4-Dichlorophenol	120-83-2				
		2,4-Dimethylphenol	105-67-9				
		2,4-Dinitrophenol	51-28-5				
		2,4-Dinitrotoluene	121-14-2				
		2,4,6-Trichlorophenol	88-06-2				
		2,6-Dinitrotoluene	606-20-2				
		2-Nitrophenol	88-75-5				
		2-Chloronaphthalene	91-58-7				
		3,3-Dichlorobenzidine	91-94-1				

TABLE C-6
GROUNDWATER ANALYTE LISTS

Constituent Group	Analyte Group	Compound/Constituent	CAS	OBJECTIVES: NE/CE Target Zones[1]	OBJECTIVES: Treated Water End Use Evaluation[2]	OBJECTIVES: Treatment System Design[3]	SAMPLE GROUP
Other Permitting[a] (Continued)	SVOCs (continued)	4-Chloro-3-Methylphenol [f]	59-50-7				Long List (continued)
		2-Methyl-4,6-Dinitrophenol	534-52-1				
		4-Nitrophenol	100-02-7				
		4-Bromophenyl Phenyl Ether	101-55-3				
		4-Chlorophenyl phenyl Ether	7005-72-3				
		Acenaphthene	83-32-9				
		Acenaphthylene	208-96-8				
		Anthracene	120-12-7				
		Benzidine	92-87-5				
		Benzo (a) Anthracene	56-55-3				
		Benzo(a)pyrene	50-32-8				
		Benzo (b) Fluoranthene	205-99-2				
		Benzo (ghi) Perylene	191-24-2				
		Benzo (k) Fluoranthene	207-08-9				
		bis (2-Chloroethoxy) methane	111-91-1				
		bis (2-Chloroethyl) Ether	111-44-4				
		bis (2-Chloroisopropyl) Ether	108-60-1				
		Benzyl Butyl Phthalate	85-68-7				
		Chrysene	218-01-9				
		Dibenzo (a,h) anthracene	53-70-3				
		Diethylphthalate	84-66-2				
		Dimethyl phthalate	131-11-3				
		di-n-Butylphthalate	84-74-2				
		di-n-Octylphthalate	117-84-0				
		Fluoranthene	206-44-0				
		Fluorene	86-73-7				
		Hexachlorobenzene	118-74-1				
		Hexachlorobutadiene	87-68-3				
		Hexachlorocyclopentadiene	77-47-4				
		Hexachloroethane	67-72-1				
		Indeno (1,2,3-cd) Pyrene	193-39-5				
		Isophorone	78-59-1				
		N-Nitrosodi-n-propylamine (NDPA) [f]	621-64-7				
		N-Nitrosodiphenylamine	86-30-6				
		Naphthalene	91-20-3				
		Nitrobenzene	98-95-3				
		Pentachlorophenol (PCP)	87-86-5				
		Phenanthrene	85-01-8				
		Phenol (Carbolic Acid)	108-95-2				
		Pyrene	129-00-0				

TABLE C-6
GROUNDWATER ANALYTE LISTS

Constituent Group	Analyte Group	Compound/Constituent	CAS	OBJECTIVES: NE/CE Target Zones[1]	OBJECTIVES: Treated Water End Use Evaluation[2]	OBJECTIVES: Treatment System Design[3]	SAMPLE GROUP
Other Permitting[a] (Continued)	Herbicides	Alachlor (ALANEX) (also UCMR 2 Monitoring-TM 525.2)	15972-60-8				Long List (continued)
		Atrazine (AATREX)	1912-24-9				
		Bentazon (BASAGRAN)	25057-89-0				
		Carbofuran (FURADAN)	1563-66-2				
		2,4-D	94-75-7				
		Dalapon	75-99-0				
		Di(2-ethylhexyl) Adipate	103-23-1				

Permits:
- Waste Discharge Requirements (WDR) Permit Only
- National Pollutant Discharge Elimination System (NPDES) Permit Only
- Both NPDES and WDR Permits

COC Chemical of concern
COPC Chemical of potential concern (RI)
NE Northern Extraction Area
CE Central Extraction Area
RI Remedial Investigation Report
VOC Volatile organic compound
SVOC Semivolatile organic comound
PCBs Polychlorinated Biphenyls

APPLICABILITY TO RESPECTIVE OBJECTIVES
- Directly relevant
- May be relevant to design of treatment system component(s), depends on end use(s) of treated groundwater
- May influence design of treatment system component(s), not expected to be treatment standard
- Based on existing data, not expected to be a concern
- Not applicable

[a] Does not include compounds or constituents that are listed in above categories
[1] Assess target zones for extraction in the respective areas
[2] Characterize the background water quality in reinjection area and/or permit requirements
[3] Characterize influent water quality to the groundwater treatment system

TABLE C-7

PUMPED AND OBSERVATION WELL LOCATIONS

Well Identifier	AREA	LSE (feet msl)	MPE (feet msl)	Screen Interval (feet bls)	HydroUnit EPA	HydroUnit DWR	OBSERVATION WELLS Same Unit	OBSERVATION WELLS Same Cluster
NE-1 MWA	NE	TBD	TBD	50 - 100	2/3	Gs	MW-9A and MW-9B	NE-1 MWB, NE-1 MWC, NE-1 MWD
NE-1 MWB	NE	TBD	TBD	120 - 150	3	H	MW-8D	NE-1 MWA, NE-1 MWC, NE-1 MWD
NE-1 MWC	NE	TBD	TBD	160 - 180	4	J	NE-2 MWC	NE-1 MWA, NE-1 MWB, NE-1 MWD
NE-1 MWD	NE	TBD	TBD	200 - 250	5/6	L	NE-2 MWD	NE-1 MWA, NE-1 MWB, NE-1 MWC
NE-2 MWA	NE	TBD	TBD	50 - 90	2	Gs	MW-8A, MW-8B and MW-8C	NE-2 MWB, NE-2 MWC, NE-2 MWD
NE-2 MWB	NE	TBD	TBD	100 - 120	3	H	MW-8D	NE-2 MWA, NE-2 MWC, NE-2 MWD
NE-2 MWC	NE	TBD	TBD	130 - 150	4	J	NE-1 MWC	NE-2 MWA, NE-2 MWB, NE-2 MWD
NE-2 MWD	NE	TBD	TBD	200 - 250	5/6	L	NE-1 MWD	NE-2 MWA, NE-2 MWB, NE-2 MWC
NE-3 MWA	NE	TBD	TBD	50 - 70	2	Ga	MW-10 and MW-25A (if not dry)	NE-3 MWB, NE-3 MWC
NE-3 MWB	NE	TBD	TBD	80 - 100	3	H	MW-25B	NE-3 MWA, NE-3 MWC
NE-3 MWC	NE	TBD	TBD	120 - 140	4	J	NE-2 MWC	NE-3 MWA, NE-3 MWB
CE-1 MWA	CE	TBD	TBD	100 - 120	3/4	WT	CE-2 MWA	CE-1 MWB, CE-1 MWC
CE-1 MWB	CE	TBD	TBD	140 - 170	4	H	CE-2 MWB	CE-1 MWA, CE-1 MWC
CE-1 MWC	CE	TBD	TBD	200 - 250	5/6	J	CE-2 MWC	CE-1 MWA, CE-1 MWB
CE-2 MWA	CE	TBD	TBD	100 - 120	3/4	WT	CE-1 MWA and/or CE-3 MWA	CE-2 MWB, CE-2 MWC
CE-2 MWB	CE	TBD	TBD	140 - 170	4	H	CE-1 MWB and/or CE-3 MWB	CE-2 MWA, CE-2 MWC
CE-2 MWC	CE	TBD	TBD	200 - 250	5/6	J	CE-1 MWC and/or CE-3 MWC	CE-2 MWA, CE-2 MWB
CE-3 MWA	CE	TBD	TBD	100 - 120	3/4	WT	CE-2 MWA	CE-3 MWB, CE-3 MWC
CE-3 MWB	CE	TBD	TBD	140 - 170	5	H	CE-2 MWB	CE-3 MWA, CE-3 MWC
CE-3 MWC	CE	TBD	TBD	200 - 250	6	J	CE-2 MWC	CE-3 MWA, CE-3 MWB
CE-4 MWA	CE	TBD	TBD	100 - 140	4	H	CE-5 MWA	SFS-Hawkins 1c_5 and 1c_4
CE-5 MWA	CE	TBD	TBD	100 - 120	3/4	WT	CE-4 MWA	CE-5 MWB, CE-5 MWC
CE-5 MWB	CE	TBD	TBD	140 - 170	5	H	MW-27B and MW-27C	CE-5 MWA, CE-5 MWC
CE-5 MWC	CE	TBD	TBD	200 - 250	6	J	CE-3 MWC and MW-27D	CE-5 MWA, CE-5 MWB

TABLE C-7

PUMPED AND OBSERVATION WELL LOCATIONS

Well Identifier	AREA	LSE (feet msl)	MPE (feet msl)	Screen Interval (feet bls)	HydroUnit EPA	HydroUnit DWR	OBSERVATION WELLS Same Unit	OBSERVATION WELLS Same Cluster
INJ-1 MWA	PR	TBD	TBD	60 - 120	3	Gs	INJ-2 MWA	Not applicable
INJ-2 MWA	PR	TBD	TBD	60 - 120	3	Gs	INJ-1 MWA and/or INJ-3 MWA	Not applicable
INJ-3 MWA	PR	TBD	TBD	60 - 110	3	Gs	INJ-2 MWA and/or INJ-4 MWA	Not applicable
INJ-4 MWA	PR	TBD	TBD	60 - 100	3	Gs	INJ-3 MWA	Not applicable
CONTINGENCY WELLS								
CINJ-1 MWA	CR	TBD	TBD	100 - 170	3/4	Ga	CINJ-2 MWA	Not applicable
CINJ-2 MWA	CR	TBD	TBD	100 - 150	3/4	Ga	CINJ-1 MWA and/or CINJ-3 MWA	Not applicable
CINJ-3 MWA	CR	TBD	TBD	100 - 110	3/4	Ga	CINJ-2 MWA	Not applicable

AREA EXPLANATION

CE Central Extraction Area
CR Contingency Reinjection Area
NE Northern Extraction Area
PR Primary Reinjection Area

HYDROUNIT EXPLANATION

Gs Gaspur aquifer
Ga Gage aquifer
H Hollydale
J Jefferson aquifer
L Lynwood aquifer
WT Water table (may not be in aquifer)

GENERAL

msl mean sea level
bls below land surface
EPA U.S. Environmental Protection Agency
DWR California Department of Water Resources
LSE Land surface elevation
MPE Measuring point elevation
TBD To be determined

TABLE C-8

PRE-DESIGN INVESTIGATION MONITOR WELL CONSTRUCTION

Well Identifier	Total Depth, feet bls	Screen Interval, feet bls	Well Casing and Screen Material	Top of Filter Pack Interval, feet bls	Top of Bentonite Pellet Seal, feet bls
Cluster NE-1:					
NE-1 MWA	105	50 - 100	4" Sch. 40 PVC casing; SS wire wrap	45	40
NE-1 MWB	155	120 - 150	4" Sch. 40 PVC casing; SS wire wrap	115	110
NE-1 MWC	185	160 - 180	4" Sch. 10 SS casing; SS wire wrap	155	150
NE-1 MWD	255*	200 - 250	4" Sch. 10 SS casing; SS wire wrap	195	190
Cluster NE-2:					
NE-2 MWA	95	50 - 90	4" Sch. 40 PVC casing; SS wire wrap	45	40
NE-2 MWB	125	100 - 120	4" Sch. 40 PVC casing; SS wire wrap	95	90
NE-2 MWC	155	130 - 150	4" Sch. 10 SS casing; SS wire wrap	125	120
NE-2 MWD	255*	200 - 250	4" Sch. 10 SS casing; SS wire wrap	195	190
Cluster NE-3:					
NE-3 MWA	75	50 - 70	4" Sch. 40 PVC casing; SS wire wrap	45	40
NE-3 MWB	105	80 - 100	4" Sch. 40 PVC casing; SS wire wrap	75	70
NE-3 MWC	145	120 - 140	4" Sch. 40 PVC casing; SS wire wrap	115	110
Cluster CE-1:					
CE-1 MWA	125	100 - 120	4" Sch. 10 SS casing; SS wire wrap	95	90
CE-1 MWB	175	140 - 170	4" Sch. 10 SS casing; SS wire wrap	135	130
CE-1 MWC	255*	200 - 250	4" Sch. 10 SS casing; SS wire wrap	195	190
Cluster CE-2:					
CE-2 MWA	125	100 - 120	4" Sch. 10 SS casing; SS wire wrap	95	90
CE-2 MWB	175	140 - 170	4" Sch. 10 SS casing; SS wire wrap	135	130
CE-2 MWC	255*	200 - 250	4" Sch. 10 SS casing; SS wire wrap	195	190

TABLE C-8

PRE-DESIGN INVESTIGATION MONITOR WELL CONSTRUCTION

Well Identifier	Total Depth, feet bls	Screen Interval, feet bls	Well Casing and Screen Material	Top of Filter Pack Interval, feet bls	Top of Bentonite Pellet Seal, feet bls
Cluster CE-3:					
CE-3 MWA	125	100 - 120	4" Sch. 10 SS casing; SS wire wrap	95	90
CE-3 MWB	175	140 - 170	4" Sch. 10 SS casing; SS wire wrap	135	130
CE-3 MWC	255*	200 - 250	4" Sch. 10 SS casing; SS wire wrap	195	190
Cluster CE-4:					
CE-4 MWA	145	100 - 140	4" Sch. 10 SS casing; SS wire wrap	95	90
Cluster CE-5:					
CE-5 MWA	125	100 - 120	4" Sch. 10 SS casing; SS wire wrap	95	90
CE-5 MWB	175	140 - 170	4" Sch. 10 SS casing; SS wire wrap	135	130
CE-5 MWC	255*	200 - 250	4" Sch. 10 SS casing; SS wire wrap	195	190
Primary Injection Area:					
INJ-1 MWA	125	60 - 120	4" Sch. 40 PVC casing; SS wire wrap	55	50
INJ-2 MWA	125	60 - 120	4" Sch. 40 PVC casing; SS wire wrap	55	50
INJ-3 MWA	125	60 - 110	4" Sch. 40 PVC casing; SS wire wrap	55	50
INJ-4 MWA	125	60 - 100	4" Sch. 40 PVC casing; SS wire wrap	55	50

TABLE C-8

PRE-DESIGN INVESTIGATION MONITOR WELL CONSTRUCTION

Well Identifier	Total Depth, feet bls	Screen Interval, feet bls	Well Casing and Screen Material	Top of Filter Pack Interval, feet bls	Top of Bentonite Pellet Seal, feet bls
Contingency Injection Area:					
CINJ-1 MWA	175	100 - 170	4" Sch. 10 SS casing; SS wire wrap	95	90
CINJ-2 MWA	155	100 - 150	4" Sch. 10 SS casing; SS wire wrap	95	90
CINJ-3 MWA	115	100 - 110	4" Sch. 10 SS casing; SS wire wrap	95	90

NOTES:

* = Actual total depth may be greater because this borehole will be converted from a deep exploratory borehole to a monitor well

bls = below land surface
Sch. 40 = Schedule 40
Sch. 10 = Schedule 10
PVC = Polyvinyl chloride
SS = Stainless steel

TABLE C-9

SCHEDULE FOR WATER LEVEL MEASUREMENTS DURING AQUIFER AND INJECTION TESTING

AQUIFER TESTING

FREQUENCY OF WATER LEVEL MEASUREMENT	TIME PERIOD
1 every 30 seconds	First 5 minutes
1 every minute	Next 10 minutes
1 every 2 minutes	Next 20 minutes
1 every 5 minutes	Next 30 minutes
1 every 10 minutes	Next 60 minutes

INJECTION TESTING

FREQUENCY OF WATER LEVEL MEASUREMENT	TIME PERIOD
1 every 30 seconds	First 5 minutes
1 every minute	Next 10 minutes
1 every 2 minutes	Next 20 minutes
1 every 5 minutes	Next 30 minutes
1 every 10 minutes	Next 60 minutes
1 every 20 minutes	Next 4 hours
1 every 30 minutes	Next 4 hours
1 every 60 minutes	For duration of test

NOTES:
Water levels may be measured more frequently depending on field conditions and water level response.

The same frequency of water level measurements will be used for both the pumping/injection and recovery phases.

TABLE C-10

ANALYTES, ANALYTICAL METHOD AND REPORTING LIMITS

Constituent Group	Analyte Group	Compound/Constituent	CAS	Analytical Method	Screening Level Concentration[1]	Reporting Units	Reporting Limit	Reporting Limit Source	SAMPLE GROUP
COCs	VOCs (Main COCs and/or RI COPCs)	Trichloroethylene (TCE)	79-01-6	EPA 8260B[2]	5	µg/L	0.5	CA DDW DLR	COCs, Moderate List, and Long List
		Tetrachloroethylene (PCE)	127-18-4	EPA 8260B[2]	5	µg/L	0.5	CA DDW DLR	
		Trichlorofluoroethane (FREON 11)	75-69-4	EPA 8260B[2]	150	µg/L	5	CA DDW DLR	
		Trichlorotrifluoroethane (FREON 113)	76-13-1	EPA 8260B[2]	1200	µg/L	10	CA DDW DLR	
		1,1-Dichloroethylene (1,1-DCE)	75-35-4	EPA 8260B[2]	6	µg/L	0.5	CA DDW DLR	
		cis-1,2-Dichloroethylene (c-1,2-DCE)	156-59-2	EPA 8260B[2]	6	µg/L	0.5	CA DDW DLR	
		Chloroform (Trichloromethane)	67-66-3	EPA 8260B[2]	80	µg/L	1	CA DDW DLR	
		Carbon tetrachloride	56-23-5	EPA 8260B[2]	0.5	µg/L	0.5	CA DDW DLR	
		1,1-Dichloroethane (1,1-DCA)	75-34-3	EPA 8260B[2]	5	µg/L	0.5	CA DDW DLR	
		1,2-Dichloroethane (1,2-DCA)	107-06-2	EPA 8260B[2]	0.5	µg/L	0.5	CA DDW DLR	
		1,1,1-Trichloroethane (1,1,1-TCA)	71-55-6	EPA 8260B[2]	200	µg/L	0.5	CA DDW DLR	
		1,1,2,2-Tetrachloroethane	79-34-5	EPA 8260B[2]	1	µg/L	0.5	CA DDW DLR	
		Dibromochloropropane (DBCP)[c]	96-12-6	EPA 504.1[3]	0.2	µg/L	0.01	CA DDW DLR	
		Ethylene Dibromide (EDB)[c]	106-93-4	EPA 504.1[3]	0.05	µg/L	0.02	CA DDW DLR	
		Benzene	71-43-2	EPA 8260B[2]	1	µg/L	0.5	CA DDW DLR	
		Carbon disulfide[d]	75-15-0	EPA 8260B[2]	160	µg/L	0.5	CA DDW DLR	
		Monochlorobenzene (Chlorobenzene)	108-90-7	EPA 8260B[2]	70	µg/L	0.5	CA DDW DLR	
		cis-1,3-Dichloropropene	10061-01-5	EPA 8260B[2]	0.5	µg/L	0.5	CA DDW DLR	
		Methyl tert-Butyl Ether (MTBE)	1634-04-4	EPA 8260B[2]	13	µg/L	3	CA DDW DLR	
		Dichloromethane (Methylene Chloride)[d]	75-09-2	EPA 8260B[2]	5	µg/L	0.5	CA DDW DLR	
		Toluene	108-88-3	EPA 8260B[2]	150	µg/L	0.5	CA DDW DLR	
		trans-1,2-Dichloroethylene (t-1,2-DCE)	156-60-5	EPA 8260B[2]	10	µg/L	0.5	CA DDW DLR	
		trans-1,3-dichloropropene	10061-02-6	EPA 8260B[2]	0.5	µg/L	0.5	CA DDW DLR	
		Vinyl Chloride (VC)	75-01-4	EPA 8260B[2]	0.5	µg/L	0.5	CA DDW DLR	
	Emergent Compounds	1,4-Dioxane	123-91-1	EPA 8270C SIM	1	µg/L	1	CA DDW DLR	
		Chromium, hexavalent (CrVI)	18540-29-9	EPA 218.6	10	ug/L	1	CA DDW DLR	
Key Treatment Constituents	SVOCs	Bis (2-Ethylhexyl)phthalate	117-81-7	EPA 525.2	4	µg/L	3	CA DDW DLR	Moderate List and Long List
	General Mineral	Aluminum (Al)	7429-90-5	EPA 200.8	50	ug/L	50	CA DDW DLR	
		Manganese (Mn)	7439-96-5	EPA 200.8	50	ug/L	20	CA DDW DLR	
		Selenium (Se)	7782-49-2	EPA 200.8	50	ug/L	5	CA DDW DLR	
		Chromium (Total Cr)	7440-47-3	EPA 200.8	50	ug/L	10	CA DDW DLR	
		Sulfate (SO4)	14808-79-8	EPA 300.0	250	mg/L	0.5	CA DDW DLR	
		Nitrate as Nitrogen (N)	14797-55-8	EPA 300.0	10	mg/L	0.4	CA DDW DLR	
		Total Dissolved Solids (TDS)	10-33-3	SM 2540 C	700	mg/L			
	Emergent Compounds	Perchlorate	14797-73-0	314.0 or 331.0	6	ug/L	4	CA DDW DLR	
General Chemistry[a]	General Mineral	Antimony	7440-36-0	EPA 200.8	6	ug/L	6	CA DDW DLR	Moderate List and Long List (continued)
		Arsenic	7440-38-2	EPA 200.8	10	ug/L	2	CA DDW DLR	
		Barium (Ba)	7440-39-3	EPA 200.8	1000	ug/L	100	CA DDW DLR	
		Beryllium	7440-41-7	EPA 200.8	4	ug/L	1	CA DDW DLR	
		Cadmium (Cd)	7440-43-9	EPA 200.8	5	ug/L	1	CA DDW DLR	
		Cobalt	7440-48-4	EPA 200.8		ug/L	(b)		
		Copper (Cu)	7440-50-8	EPA 200.8	1000	ug/L	50	CA DDW DLR	
		Iron (Fe)	7439-89-6	EPA 200.8	300	ug/L	100	CA DDW DLR	
		Lead (Pb)	7439-92-1	EPA 200.8	15	ug/L	5	CA DDW DLR	
		Molybdenum	7439-98-7	EPA 200.8		ug/L	(b)		
		Mercury (Hg)	7439-97-6	Epa 245.1	2	ug/L	1	CA DDW DLR	
		Nickel	7440-02-0	EPA 200.8	100	ug/L	10	CA DDW DLR	
		Silver (Ag)	7440-22-4	EPA 200.8	100	ug/L	10	CA DDW DLR	
		Thallium	7440-28-0	EPA 200.8	2	ug/L	1	CA DDW DLR	
		Vanadium	7440-62-2	EPA 200.8	50	ug/L	3	CA DDW DLR	
		Zinc (Zn)	7440-66-6	EPA 200.8	5000	ug/L	50	CA DDW DLR	
		Chloride	16887-00-6	EPA 300.0	150	mg/L	(b)		
		Alkalinity, (Total) (as CaCO3 equivalents)	TOT-ALK	SM 2320B		mg/L	(b)		
		Bicarbonate (as HCO3)	71-52-3	SM 2320B		mg/L	(b)		
		Calcium (Ca)	7440-70-2	EPA 200.7		mg/L	(b)		
		Sodium (Na)		EPA 200.7		mg/L	(b)		
		Potassium (K)	7440-09-7	EPA 200.7		mg/L	(b)		
		Magnesium (Mg)	7439-95-4	EPA 200.7		mg/L	(b)		
		Fluoride (F) (Natural-Source)	16984-48-8	EPA 300.0	2	mg/L	0.1	CA DDW DLR	
		Boron	7440-42-8	EPA 200.7	1000	ug/L	100	CA DDW DLR	
		Silica	7631-86-9	EPA 200.7		mg/L	(b)		
		Phosphate (as PO4)	PO4	EPA 365.1		mg/L	(b)		
		Ammonia	NH3	EPA 350.1		mg/L	(b)		
Treatment System[a]	General Mineral	Uranium	7440-61-1	EPA 200.8		ug/L	1	CA DDW DLR	
		Strontium	7440-24-6	EPA 200.8		ug/l	(b)		
Emergent Compounds[a]		n-Nitrosodimethylamine (NDMA)	10595-95-6	EPA 1625C	0.01	µg/L	0.01	Screening level	
		1,2,3-Trichloropropane	96-18-4	SRL 524M-TCP	0.005	µg/L	0.005	CA DDW DLR	
Other Permitting[a]	VOCs	1,1,2-Trichloroethane (1,1,2-TCA)	79-00-5	EPA 524.2	5	µg/L	0.5	CA DDW DLR	Long List
		1,2-Dichlorobenzene (o-DCB)	95-50-1	EPA 524.2	600	µg/L	0.5	CA DDW DLR	
		1,2-Dichloropropane	78-87-5	EPA 524.2	5	µg/L	0.5	CA DDW DLR	
		1,3-Dichlorobenzene (m-DCB)	541-73-1	EPA 524.2		µg/L	0.5	CA DDW DLR	
		1,3-Dichloropropene, Total	542-75-6	EPA 524.2	0.5	µg/L	0.5	CA DDW DLR	
		1,4-Dichlorobenzene (p-DCB)	106-46-7	EPA 524.2	5	µg/L	0.5	CA DDW DLR	
		2-Chloroethylvinyl Ether	110-75-8	EPA 524.2		µg/L	1	RWQCB, E	
		Acetone	67-64-1	EPA 524.2		µg/L	(b)		

TABLE C-10

ANALYTES, ANALYTICAL METHOD AND REPORTING LIMITS

Constituent Group	Analyte Group	Compound/Constituent	CAS	Analytical Method	Screening Level Concentration[1]	Reporting Units	Reporting Limit	Reporting Limit Source	SAMPLE GROUP
Other Permitting[a]	VOCs	Acrolein	107-02-8	EPA 524.2		ug/l	5	RWQCB, E	Long List
		Acrylonitrile (Acritet)	107-13-1	EPA 524.2		µg/L	2	RWQCB, E	
		Bromoform	75-25-2	EPA 524.2		µg/L	0.5	RWQCB, E	
		Dibromochloromethane	124-48-1	EPA 524.2		µg/L	0.5	RWQCB, E	
		Chloroethane	75-00-3	EPA 524.2		µg/L	0.5	CA DDW DLR	
		Bromodichloromethane	75-27-4	EPA 524.2		µg/L	0.5	RWQCB, E	
		Ethyl Benzene	100-41-4	EPA 524.2	300	µg/L	0.5	CA DDW DLR	
		Bromomethane (Methyl Bromide)	74-83-9	EPA 524.2		µg/L	0.5	CA DDW DLR	
		Chloromethane (Methyl Chloride)	74-87-3	EPA 524.2		µg/L	0.5	CA DDW DLR	
		Diisopropyl Ether (DIPE)	108-20-3	EPA 524.2		µg/L	2	RWQCB, E	
		Methyl Ethyl Ketone (MEK, Butanone)	78-93-3	EPA 524.2		µg/L	5	CA DDW DLR	
		tert-Amyl Methyl Ether (TAME)	994-05-8	EPA 524.2		µg/L	2	RWQCB, E	
		tert-Butyl Alcohol (TBA)	75-65-0	EPA 524.2	12	µg/L	2	CA DDW DLR	
		Styrene	100-42-5	EPA 524.2	100	µg/L	0.5	CA DDW DLR	
		m,p-Xylene	179601-23-1	EPA 524.2		µg/L	0.5	CA DDW DLR	
		Total Xylenes (m,p, & o)	1330-20-7	EPA 524.2	1750	µg/L	(b)		
	General Mineral	Asbestos	1332-21-4	EPA 100.1/100.2	7	MFL	0.2	CA DDW DLR	
		Chemical oxygen demand	--	410.4			(b)		
		pH	12408-02-5	SM 4500 H+B (or field)		Std Units	(b)		
		Oxidation-reduction potential	--	ASTM D 1498 (or field)			(b)		
		Dissolved oxygen	--	SM 4500 O G (or field)			(b)		
		Carbon Dioxide	124-38-9	RSK-175		ug/L	(b)		
		Nitrate + Nitrite as Nitrogen (N)	NO3NO2	300.0	10	mg/L	0.4	CA DDW DLR	
		Combined Radium-226 and Radium-228	7440-14-4	EPA 903.0, Ra-05	5	pCi/L	1	CA DDW DLR	
		Gross Alpha	12587-46-1	EPA 900.0	15	pCi/L	3	CA DDW DLR	
		Tritium	10028-17-8	EPA 906.0	20000	pCi/L	1000	CA DDW DLR	
		Strontium – 90	10098-97-2	EPA 905.0	8	pCi/L	2	CA DDW DLR	
		Gross Beta	12587-47-2	EPA 900.0	50	pCi/L	4	CA DDW DLR	
		Uranium	7440-61-1	EPA 200.8	20	pCi/L	1	CA DDW DLR	
	Misc	Total petroleum hydrocarbons	--	EPA 8015B			(b)		
		Biochemical oxygen demand	--	SM5210B			(b)		
		Methane	74-82-8	RSK-175			(b)		
		Temperature	--	Field Measurement			(b)		
		Coliform[f]	--	SM 9221B	1.1	MPN/100ml	(b)		
		Ethanol	64-17-5	EPA 8015B		µg/L	1000	RWQCB, E	
		Methanol	67-56-1	EPA 8015B		µg/L	1000	RWQCB, E	
		Cyanide	57-12-5	SM 4500 CN E	150	ug/L	5	RWQCB, E	
		2,3,7,8-TCDD (Dioxin)	1746-01-6	EPA 1613B	30	pg/L	5	CA DDW DLR	
	Pesticides and PCBs	4,4'-DDD	72-54-8	EPA 608, LL		µg/L	0.02	CA DDW DLR	
		4,4'-DDE	72-55-9	EPA 608, LL		µg/L	0.01	CA DDW DLR	
		4,4'-DDT	50-29-3	EPA 608, LL		µg/L	0.01	RWQCB, E	
		Endosulfan I	959-98-8	EPA 608, LL		µg/L	0.01	CA DDW DLR	
		alpha-BHC	319-84-6	EPA 608, LL		µg/L	0.01	CA DDW DLR	
		Aldrin	309-00-2	EPA 608, LL		µg/L	0.005	RWQCB, E	
		Endosulfan II	33213-65-9	EPA 608, LL		µg/L	0.01	CA DDW DLR	
		beta-BHC	319-85-7	EPA 608, LL		µg/L	0.005	RWQCB, E	
		Chlordane	57-74-9	EPA 608, LL	0.1	µg/L	0.1	CA DDW DLR	
		delta-BHC	319-86-8	EPA 608, LL		µg/L	0.005	RWQCB, E	
		Dieldrin	60-57-1	EPA 608, LL		µg/L	0.01	RWQCB, E	
		Endosulfan Sulfate	1031-07-8	EPA 608, LL		µg/L	0.05	CA DDW DLR	
		Endrin	72-20-8	EPA 608, LL	2	µg/L	0.01	RWQCB, E	
		Endrin Aldehyde	7421-93-4	EPA 608, LL		µg/L	0.01	RWQCB, E	
		Heptachlor	76-44-8	EPA 608, LL	0.01	µg/L	0.01	CA DDW DLR	
		Heptachlor Epoxide	1024-57-3	EPA 608, LL	0.01	µg/L	0.01	CA DDW DLR	
		gamma-BHC	58-89-9	EPA 608, LL	0.2	µg/L	0.02	RWQCB, E	
		PCB-1016 (as decachlorobiphenyl (DCB))	12674-11-2	EPA 608, LL		µg/L	0.5	CA DDW DLR	
		PCB-1221 (as DCB)	11104-28-2	EPA 608, LL		µg/L	0.5	CA DDW DLR	
		PCB-1232 (as DCB)	11141-16-5	EPA 608, LL		µg/L	0.5	CA DDW DLR	
		PCB-1242 (as DCB)	53469-21-9	EPA 608, LL		µg/L	0.5	CA DDW DLR	
		PCB-1248 (as DCB)	12672-29-6	EPA 608, LL		µg/L	0.5	CA DDW DLR	
		PCB-1254 (as DCB)	11097-69-1	EPA 608, LL		µg/L	0.5	CA DDW DLR	
		PCB-1260 (as DCB)	11096-82-5	EPA 608, LL		µg/L	0.5	CA DDW DLR	
		Toxaphene	8001-35-2	EPA 608, LL	3	µg/L	0.5	RWQCB, E	
	SVOCs	1,2-Diphenylhydrazine	122-66-7	EPA 625 SIM		µg/L	(b)		
		1,2,4-Trichlorobenzene	120-82-1	EPA 625 SIM	5	µg/L	0.5	CA DDW DLR	
		2-Chlorophenol	95-57-8	EPA 625 SIM		µg/L	5	CA DDW DLR	
		2,4-Dichlorophenol	120-83-2	EPA 625 SIM		µg/L	5	CA DDW DLR	
		2,4-Dimethylphenol	105-67-9	EPA 625 SIM		µg/L	2	RWQCB, E	
		2,4-Dinitrophenol	51-28-5	EPA 625 SIM		µg/L	5	CA DDW DLR	
		2,4-Dinitrotoluene	121-14-2	EPA 625 SIM		µg/L	5	CA DDW DLR	
		2,4,6-Trichlorophenol	88-06-2	EPA 625 SIM		µg/L	5	CA DDW DLR	
		2,6-Dinitrotoluene	606-20-2	EPA 625 SIM		µg/L	5	CA DDW DLR	
		2-Nitrophenol	88-75-5	EPA 625 SIM		µg/L	5	CA DDW DLR	
		2-Chloronaphthalene	91-58-7	EPA 625 SIM		µg/L	5	CA DDW DLR	
		3,3-Dichlorobenzidine	91-94-1	EPA 625 SIM		µg/L	5	RWQCB, E	

TABLE C-10

ANALYTES, ANALYTICAL METHOD AND REPORTING LIMITS

Constituent Group	Analyte Group	Compound/Constituent	CAS	Analytical Method	Screening Level Concentration[1]	Reporting Units	Reporting Limit	Reporting Limit Source	SAMPLE GROUP
Other Permitting[a] (Continued)	SVOCs	4-Chloro-3-Methylphenol[f]	59-50-7	EPA 625 SIM		µg/L	1	RWQCB, E	Long List (continued)
		2-Methyl-4,6-Dinitrophenol	534-52-1	EPA 625 SIM		µg/L	5	CA DDW DLR	
		4-Nitrophenol	100-02-7	EPA 625 SIM		µg/L	5	CA DDW DLR	
		4-Bromophenyl Phenyl Ether	101-55-3	EPA 625 SIM		µg/L	5	CA DDW DLR	
		4-Chlorophenyl phenyl Ether	7005-72-3	EPA 625 SIM		µg/L	5	CA DDW DLR	
		Acenaphthene	83-32-9	EPA 625 SIM		µg/L	1	RWQCB, E	
		Acenaphthylene	208-96-8	EPA 625 SIM		µg/L	5	CA DDW DLR	
		Anthracene	120-12-7	EPA 625 SIM		µg/L	5	CA DDW DLR	
		Benzidine	92-87-5	EPA 625 SIM		µg/L	5	CA DDW DLR	
		Benzo (a) Anthracene	56-55-3	EPA 625 SIM		µg/L	5	RWQCB, E	
		Benzo(a)pyrene	50-32-8	EPA 625 SIM	0.2	µg/L	0.1	CA DDW DLR	
		Benzo (b) Fluoranthene	205-99-2	EPA 625 SIM		µg/L	10	CA DDW DLR	
		Benzo (ghi) Perylene	191-24-2	EPA 625 SIM		µg/L	5	RWQCB, E	
		Benzo (k) Fluoranthene	207-08-9	EPA 625 SIM		µg/L	2	RWQCB, E	
		bis (2-Chloroethoxy) methane	111-91-1	EPA 625 SIM		µg/L	5	CA DDW DLR	
		bis (2-Chloroethyl) Ether	111-44-4	EPA 625 SIM		µg/L	(b)		
		bis (2-Chloroisopropyl) Ether	108-60-1	EPA 625 SIM		µg/L	5	CA DDW DLR	
		Benzyl Butyl Phthalate	85-68-7	EPA 625 SIM		µg/L	10	CA DDW DLR	
		Chrysene	218-01-9	EPA 625 SIM		µg/L	5	CA DDW DLR	
		Dibenzo (a,h) anthracene	53-70-3	EPA 625 SIM		µg/L	0.1	RWQCB, E	
		Diethylphthalate	84-66-2	EPA 625 SIM		µg/L	5	CA DDW DLR	
		Dimethyl phthalate	131-11-3	EPA 625 SIM		µg/L	5	CA DDW DLR	
		di-n-Butylphthalate	84-74-2	EPA 625 SIM		µg/L	5	CA DDW DLR	
		di-n-Octylphthalate	117-84-0	EPA 625 SIM		µg/L	5	CA DDW DLR	
		Fluoranthene	206-44-0	EPA 625 SIM		µg/L	5	CA DDW DLR	
		Fluorene	86-73-7	EPA 625 SIM		µg/L	5	CA DDW DLR	
		Hexachlorobenzene	118-74-1	EPA 625 SIM	1	µg/L	0.5	CA DDW DLR	
		Hexachlorobutadiene	87-68-3	EPA 625 SIM		µg/L	0.5	CA DDW DLR	
		Hexachlorocyclopentadiene	77-47-4	EPA 625 SIM	50	µg/L	1	CA DDW DLR	
		Hexachloroethane	67-72-1	EPA 625 SIM		µg/L	1	RWQCB, E	
		Indeno (1,2,3-cd) Pyrene	193-39-5	EPA 625 SIM		µg/L	0.05	RWQCB, E	
		Isophorone	78-59-1	EPA 625 SIM		µg/L	1	RWQCB, E	
		N-Nitrosodi-n-propylamine (NDPA)[f]	621-64-7	EPA 625 SIM	0.01	µg/L	(b)		
		N-Nitrosodiphenylamine	86-30-6	EPA 625 SIM		µg/L	(b)		
		Naphthalene	91-20-3	EPA 625 SIM	17	µg/L	0.5	CA DDW DLR	
		Nitrobenzene	98-95-3	EPA 625 SIM		µg/L	(b)		
		Pentachlorophenol (PCP)	87-86-5	EPA 515.3	1	µg/L	0.2	CA DDW DLR	
		Phenanthrene	85-01-8	EPA 625 SIM		µg/L	5	CA DDW DLR	
		Phenol (Carbolic Acid)	108-95-2	EPA 625 SIM		µg/L	5	CA DDW DLR	
		Pyrene	129-00-0	EPA 625 SIM		µg/L	5	CA DDW DLR	
	Herbicides	Alachlor (ALANEX) (also UCMR 2 Monitoring-TM 525.2)	15972-60-8	EPA 525.2	2	µg/L	1	CA DDW DLR	
		Atrazine (AATREX)	1912-24-9	EPA 525.2	1	µg/L	0.5	CA DDW DLR	
		Bentazon (BASAGRAN)	25057-89-0	EPA 515.3	18	µg/L	2	CA DDW DLR	
		Carbofuran (FURADAN)	1563-66-2	EPA 531.1	18	µg/L	5	CA DDW DLR	
		2,4-D	94-75-7	EPA 515.3	70	µg/L	10	CA DDW DLR	
		Dalapon	75-99-0	EPA 515.3	200	µg/L	10	CA DDW DLR	
		Di(2-ethylhexyl) Adipate	103-23-1	EPA 525.2	400	µg/L	5	CA DDW DLR	

NOTES:

- Waste Discharge Requirements (WDR) Permit Only
- National Pollutant Discharge Elimination System (NPDES) Permit Only
- Both NPDES and WDR Permits

[1] Pursuant to RWQCB-LA WDR Order No. R4-2014-0187: Treated groundwater that exhibits general mineral content that is naturally occurring and exceeds Basin Plan Objectives may be returned to the same groundwater aquifers from which it is withdrawn, with concentrations not exceeding the original background concentrations for the site

[2] EPA Method 8260B will be used to analyze VOCs for COC sampling events. The laboratory reporting level for VOCs in 8260B scan may not meet CA DDW DLRs; however, they will be equal to or below screening levels with exception of those constituents indicated with "c" or "d". EPA Method 524.2 will be used for moderate and long list events.

[3] These compounds will be analyzed using EPA Methods 8260B during COC events; using 524.4 during moderate list events; and using EPA Method 504.1 during long list events.

[a] Does not include compounds or constituents that are listed in above categories

[b] Standard methods and detection limits apply

[c] This compound will be analyzed using EPA Method 504.1 for Long List sampling when CA DDW DLR levels required; otherwise, analysis will be by EPA Method 8260B

[d] Method detection limits for 8260B above CA DDW DLR levels; however, below screening levels.

[f] Detections below the reporting limit will be indicated by a "J" flag, if applicable. However, lowest screening level is below Method Detection Limit achievable by lab

-- Not applicable

COC	Chemical of concern	MPN/100ml	Most Probable Number per 100 milliliters
COPC	Chemical of potential concern (RI)	ug/l	Micrograms per liter
RI	Remedial Investigation Report	pg/l	Picograms per liter
VOC	Volatile organic compound	pCi/L	picocuries per liter
SVOC	Semivolatile organic compound	mg/l	milligrams per liter
misc	Miscelllaneous	MFL	Million fibers per liter
PCBs	Polychlorinated Biphenyls		

CA DDW DLR California State Water Resources Control Board, Division of Drinking Water, detection limit for purposes of reporting based on drinking water standards and best available analytical methods

RWQCB, E California Regional Water Quality Control Board, Los Angeles Region. Appendix E reporting limit for NPDES permit.

TABLE C-11

HANDLING PROTOCOL FOR WATER SAMPLES

ANALYTE	ANALYTE LIST	EPA METHOD	SAMPLE CONTAINER	OTHER REQUIREMENTS	PRESERVATION METHOD	MAXIMUM HOLDING TIME
PRIMARY ANALYSES, CHEMICALs OF CONCERN						
VOLATILE ORGANIC COMPOUNDS	COCs (524.4 used for Moderage and Long Lists)	8260B	3 X 40 ml VOA VIAL, TEFLON LINED SEPTUM	VIALS FILLED COMPLETELY, NO HEAD SPACE	HCl, COOL TO 4ºC	14 DAYS
1,4-DIOXANE	COCs, Moderate and Long Lists	8270C SIM	1-liter AMBER GLASS	FILL TO NECK	COOL TO 4ºC	7 DAYS
HEXAVALENT CHROMIUM	COCs, Moderate and Long Lists	218.6	250 ml HDPE	FILL TO NECK	COOL TO 4ºC	24 HOURS
COMPREHENSIVE ANALYSES, COMPOUNDS OF POTENTIAL CONCERN AND TREATMENT SYSTEM DESIGN PARAMETERS						
OTHER ORGANIC COMPOUNDS						
1,2,3-Trichloropropane	Moderate and Long Lists	SRL 524M	3 X 40 ml VOA VIAL, TEFLON LINED SEPTUM	VIALS FILLED COMPLETELY, NO HEAD SPACE	HCl, COOL TO 4ºC	14 DAYS
Bis(2-ethylhexyl)phthalate	Moderate and Long Lists	625	1-liter AMBER GLASS	FILL TO NECK	COOL TO 4ºC	7 DAYS
EDB and DBCP	Moderate and Long List	504.1	3 X 40 ml VOA VIAL, TEFLON LINED SEPTUM	VIALS FILLED COMPLETELY, NO HEAD SPACE	SODIUM THIOSULFATE, COOL TO 4ºC	14 DAYS
NDMA	Moderate and Long Lists	1625C	1-liter AMBER GLASS	FILL TO NECK	COOL TO 4ºC	7 DAYS
METALS, INCLUDING STRONTIUM AND URANIUM	Moderate and Long Lists	6020, 200.8, 200.7, 7470A	250 ml HDPE	FIELD FILTER[1], FILL TO NECK	ULTRA HNO_3[1], COOL TO 4ºC	28 DAYS
OTHER INORGANIC CONSTITUENTS						
Perchlorate		314.0, 331.0	125 ml STERILE HDPE	FILL TO NECK	COOL TO 4ºC	28 DAYS
Ammonia		350.1	1-liter AMBER GLASS	FILL TO NECK	H_2SO_4, COOL TO 4ºC	28 DAYS
Chemical Oxygen Demand		410.4	1-liter AMBER GLASS	FILL TO NECK	H_2SO_4, COOL TO 4ºC	28 DAYS
Total Phosphate		365.1	1-liter AMBER GLASS	FILL TO NECK	H_2SO_4, COOL TO 4ºC	28 DAYS
Total Organic Carbon	Moderate and Long Lists	5310B/D	1-liter AMBER GLASS	FILL TO NECK	H_2SO_4, COOL TO 4ºC	28 DAYS
Total Dissolved Solids		2540C	1-liter HDPE	FILL TO NECK	COOL TO 4ºC	7 DAYS
Total Suspended Solids		2540D	1-liter HDPE	FILL TO NECK	COOL TO 4ºC	7 DAYS
Common Anions		300.0	1-liter HDPE	FILL TO NECK	COOL TO 4ºC	28 DAYS
Nitrate NO_3		300.0	1-liter HDPE	FILL TO NECK	COOL TO 4ºC	48 HOURS
Alkalinity, Carbonate, Bicarbonate		SM 2320	1-liter HDPE	FILL TO NECK	COOL TO 4ºC	14 DAYS
pH		SM 4500-H+B	1-liter HDPE	FILL TO NECK	COOL TO 4ºC	15 MINUTES*
EXPANDED COMPREHENSIVE ANALYSES, DISCHARGE PERMIT-REQUIRED ANALYSES						
VOLATILE ORGANIC COMPOUNDS	Moderate and Long List	524.2	3 X 40 ml VOA VIAL, TEFLON LINED SEPTUM	VIALS FILLED COMPLETELY, NO HEAD SPACE	HCl, COOL TO 4ºC	14 DAYS
SEMIVOLATILE ORGANIC COMPOUNDS	Long List	625 SIM	1-liter AMBER GLASS	FILL TO NECK	COOL TO 4ºC	7 DAYS

TABLE C-11

HANDLING PROTOCOL FOR WATER SAMPLES

ANALYTE	ANALYTE LIST	EPA METHOD	SAMPLE CONTAINER	OTHER REQUIREMENTS	PRESERVATION METHOD	MAXIMUM HOLDING TIME
EXPANDED COMPREHENSIVE ANALYSES, DISCHARGE PERMIT-REQUIRED ANALYSES (continued)						
TOTAL PETROLEUM HYDROCARBONS (TPH)						
TPH - Gasoline Range	Long List	8015B (GRO)	3 X 40 ml VOA VIAL, TEFLON LINED SEPTUM	VIALS FILLED COMPLETELY, NO HEAD SPACE	HCl, COOL TO 4ºC	14 DAYS
TPH - Diesel Range	Long List	8015 (DRO)	500 ml AMBER GLASS	FILL TO NECK	COOL TO 4ºC	7 DAYS
RADIOACTIVITY AND RADIOISOTOPES						
Gross Alpha and Beta		900.0	1-liter HDPE	FILL TO NECK	NONE	6 MONTHS
Radium-226		903.0	1-liter HDPE	FILL TO NECK	HNO_3, COOL TO 4ºC	6 MONTHS
Radium-228	Long List	Ra-05	2 X 1-liter HDPE	FILL TO NECK	HNO_3, COOL TO 4ºC	6 MONTHS
Strontium-90		905.0	1-liter HDPE	FILL TO NECK	HNO_3, COOL TO 4ºC	6 MONTHS
Tritium		906.0	2 X 125 ml HDPE	FILL TO NECK	NONE	6 MONTHS
PESTICIDES, POLYCHLORINATED BIPHENYLS	Long List	608 Low Level	2 X 1-liter AMBER GLASS	FILL TO NECK	COOL TO 4ºC	7 DAYS
HERBICIDES AND RELATED COMPOUNDS						
Herbicides, Pentachlorophenol		515.3	250 ml AMBER GLASS	FILL TO NECK	COOL TO 4ºC	14 DAYS
Alachlor, Atrazine, Di(2-ethylhexyl) Adipate		525.2	2 X 1-liter AMBER GLASS	FILL TO NECK	HCl, COOL TO 4ºC	14 DAYS
Carbofuran	Long List	531.1	40 ml VOA VIAL, TEFLON LINED SEPTUM	VIAL FILLED COMPLETELY, NO HEAD SPACE	MCAA, COOL TO 4ºC	28 DAYS
2,3,7,8-TCDD (Dioxin)		1613B	2 X 1-liter AMBER GLASS	FILL TO NECK	COOL TO 4ºC	12 MONTHS
MISCELLANEOUS ORGANIC AND INORGANIC CONSTITUENTS						
Asbestos		100.1 / 100.2	1-liter HDPE	FILL TO NECK	COOL TO 4ºC	48 HOURS
Cyanide, total		SM 4500-CN E	500 ml HDPE	FILL TO NECK	NaOH, COOL TO 4ºC	14 DAYS
Dissolved Oxygen		SM 4500-O G	125 ml HDPE	FILL TO NECK	COOL TO 4ºC	15 MINUTES*
Carbon dioxide		RSK 175	2 X 40 ml VOA VIALS, TEFLON LINED SEPTUM	VIALS FILLED COMPLETELY, NO HEAD SPACE	COOL TO 4ºC	7 DAYS
Oxidation - Reduction potential	Long List	ASTM D 1498	125 ml HDPE	FILL TO NECK	COOL TO 4ºC	24 HOURS
Biochemical Oxygen Demand (BOD)		SM 5210 B (BOD)	1-liter HDPE	FILL TO NECK	COOL TO 4ºC	48 HOURS
Methane		RSK 175	2 X 40 ml VOA VIALS, TEFLON LINED SEPTUM	VIALS FILLED COMPLETELY, NO HEAD SPACE	HCl, COOL TO 4ºC	14 DAYS
Methanol, Ethanol		8015B	2 X 40 ml VOA VIALS, TEFLON LINED SEPTUM	VIALS FILLED COMPLETELY, NO HEAD SPACE	COOL TO 4ºC	7 DAYS
Coliform bacteria		SM 9221B	125 ml STERILE POLY	FILL TO NECK	THIOSULFATE, COOL TO 4ºC	6 HOURS

FOOTNOTES

[1]Field filtering reqauired if using acid preserved bottles. Alternatively, can collec tsample sin unacidified sample container and have laboratory filter and acidify upon receipt.

°C = degrees Celsius
EPA = U.S. Environmental Protection Agency
HCl = Hydrochloric Acid
ml = Milliliter
VOA = Volatile Organic Analysis
Na_2SO_3 = Sodium sulfite

$NaHSO_4$ = Sodium Bisulfate
HDPE = High density polyethylene
EDB = Ethylene dibromide
DBCP = 1,2-Dibromo-3-chloropropane
HNO_3 = Nitric Acid
H_2SO_4 = Sulfuric Acid

SRL = Department of Health's Sanitation and Radiation Laboratories
ASTM = American Society for Testing and Materials
SM = Standard Method
NDMA = N-Nitrosodimethylamine
MCAA = Monochloroacetic acid
* = Field measurements will be used as an alternative, due to short holding time

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APPENDIX C FIGURES

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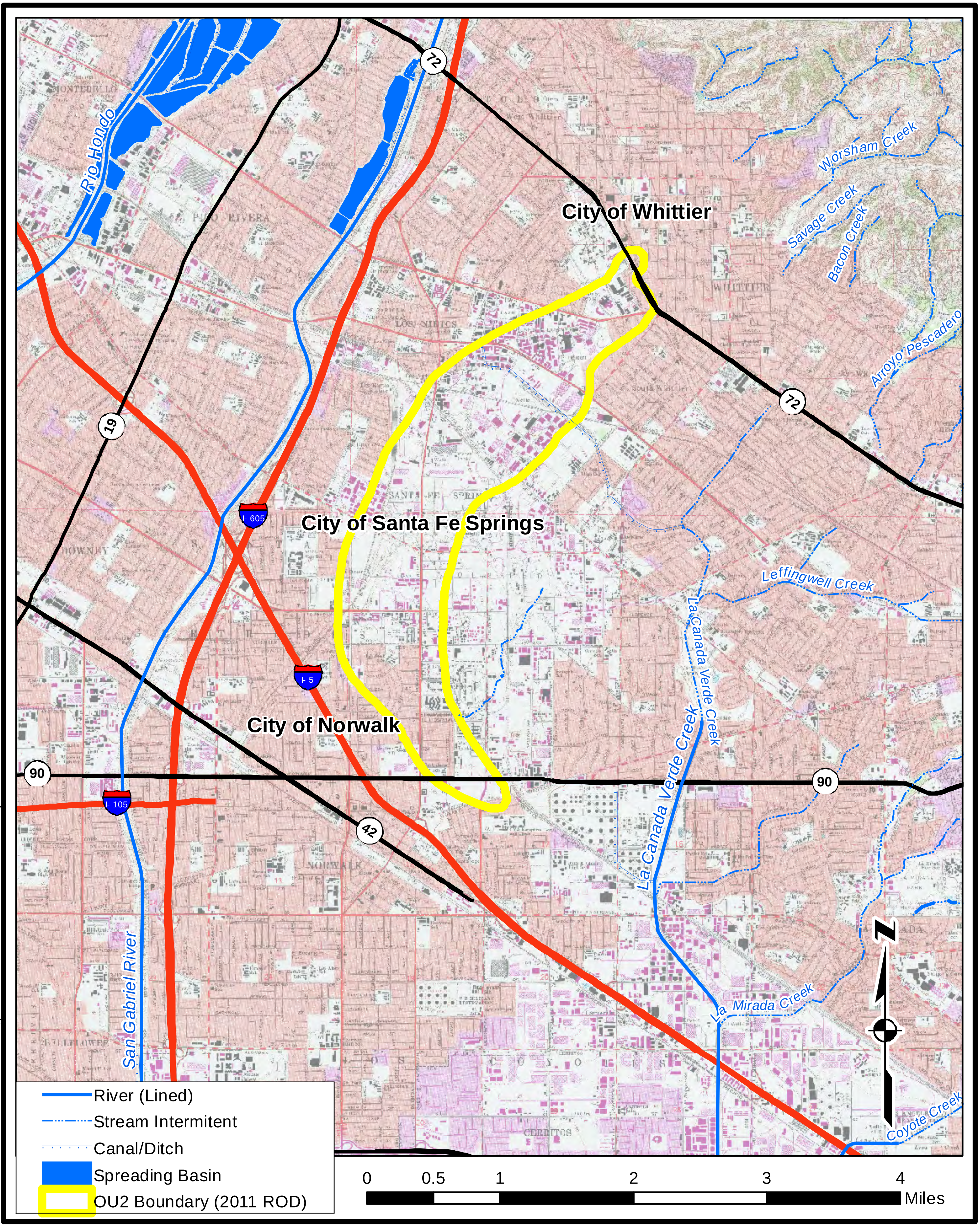

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FIGURE C-1. SITE LOCATION

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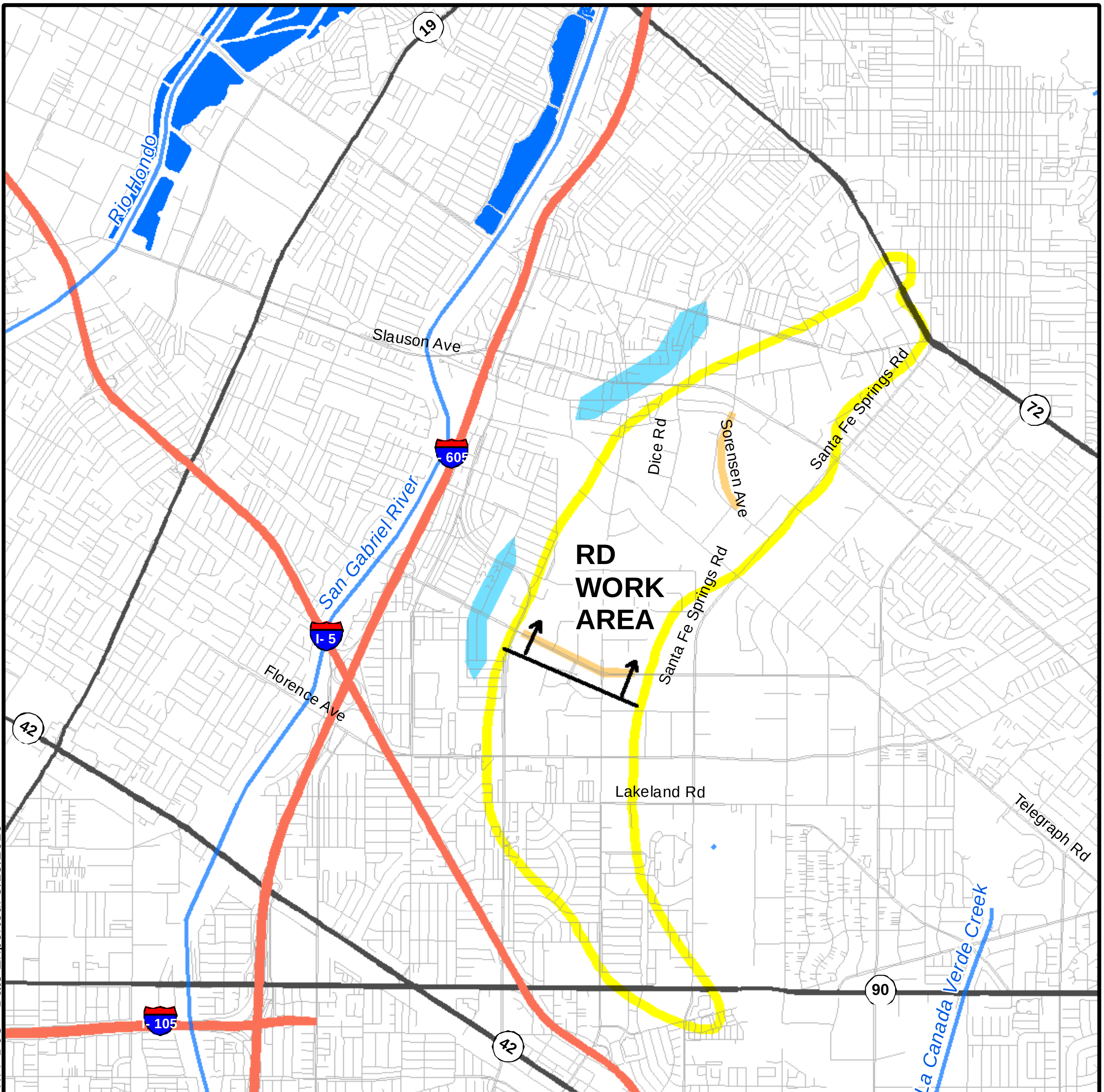

- Spreading Basin
- OU2 Boundary (2011 ROD)
- River (Lined)
- Remedial Design Work Area
- Potential Reinjection Areas
- Potential Locations of NE/CE Area Extraction Wells

NOTES:

Remedial Design Work Area (RDWA) includes Northern Extraction (NE) and Central Extraction (CE) areas. Also includes the following end uses for treated groundwater:

1) Shallow reinjection (illustrated above as potential reinjection areas)
2) Spreading basin recharge (illustrated above as spreading basin)
3) Reclaimed use (non-potable, not illustrated)
4) Deep reinjection (not illustrated)

0 0.25 0.5 1 1.5 2 Miles

N

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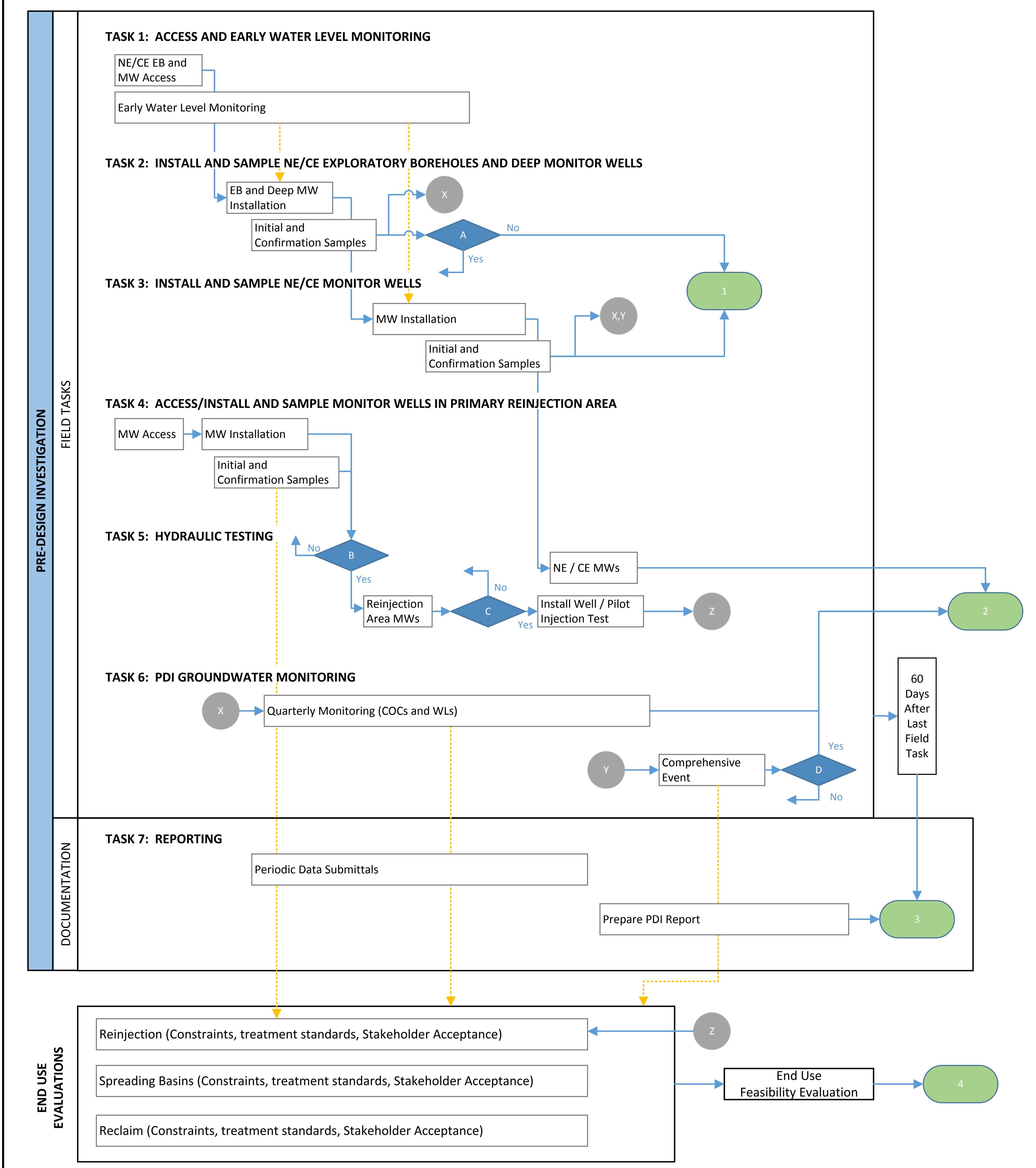
FIGURE C-2. REMEDIAL DESIGN WORK AREA



EXPLANATION AND ACRONYMS

NE	Northern Extraction Area	COC	Chemical of Concern	EB	Exploratory Borehole
CE	Central Extraction Area	PDI	Pre-Design Investigation	MW	Monitor Well
WL	Water Level				

Z On Page Flow chart connector — D Flow chart decision — 3 Flow chart terminator

Flow chart key predecessor/successor task — Flow chart information

DECISIONS AND TERMINATIONS

A	Are additional deep PDI monitor wells required?	If yes, install per PDI plan.
B	Is subject reinjection area viable based on water quality results?	If yes, proceed to next step.
C	Is subject reinjection area viable based on hydraulic testing results?	If no, consider evaluating alternate reinjection area.
D	Results consistent?	If no, conduct additional sampling to resolve.

1 Define target zones of NE and CE areas based on COC results from PDI and selected existing monitor wells.
2 Estimate extraction rates and influent water quality to treatment system (outside PDI, part of remedial design).
3 Submit PDI Report 60 days after final PDI Field Task Completed.
4 Recommend end use(s) for treated groundwater and obtain EPA concurrence (outside PDI).

FIGURE C-3. PRE-DESIGN INVESTIGATION TASKS

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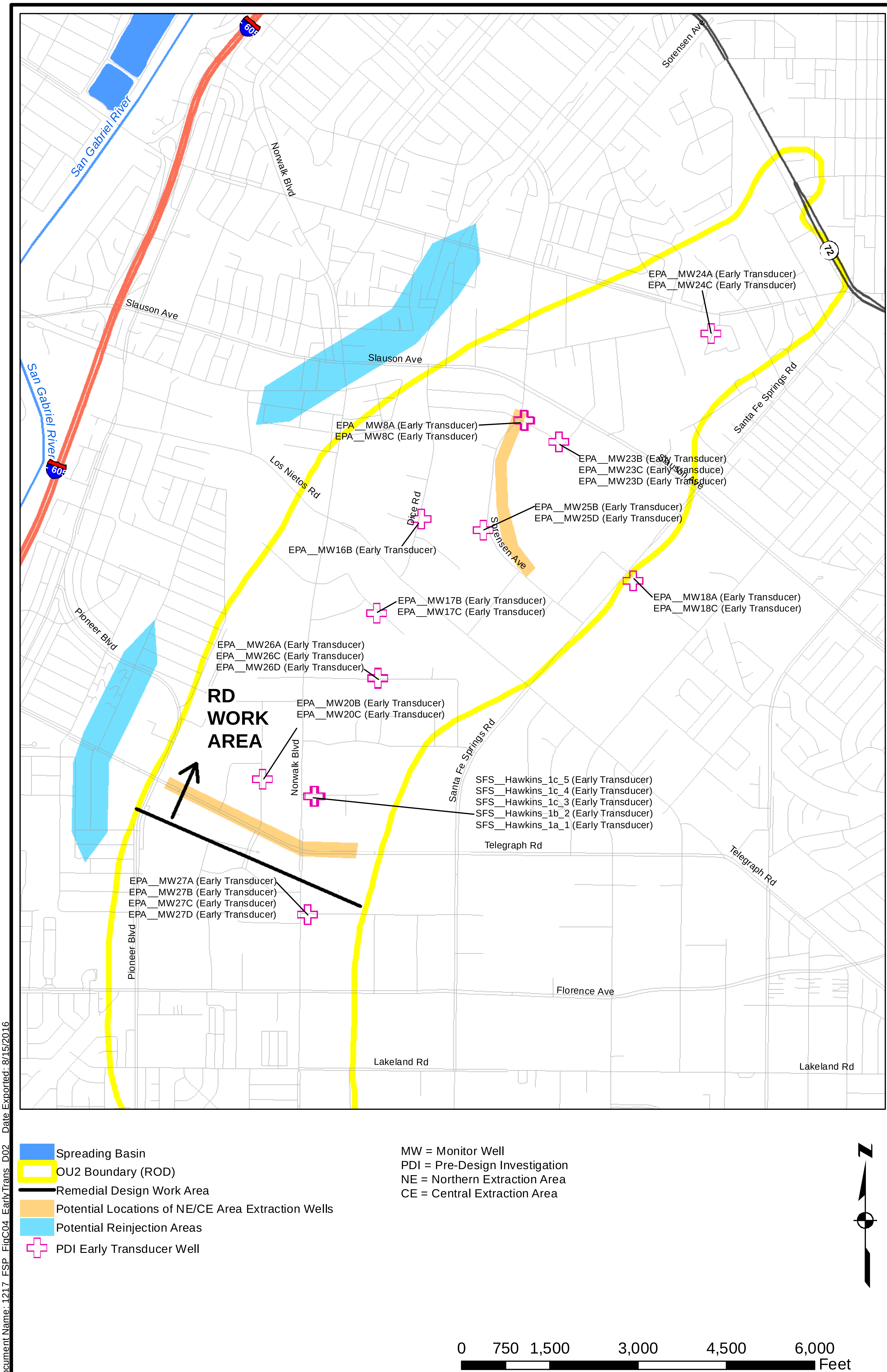

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FIGURE C-4. EARLY WATER LEVEL TRANSDUCER LOCATIONS

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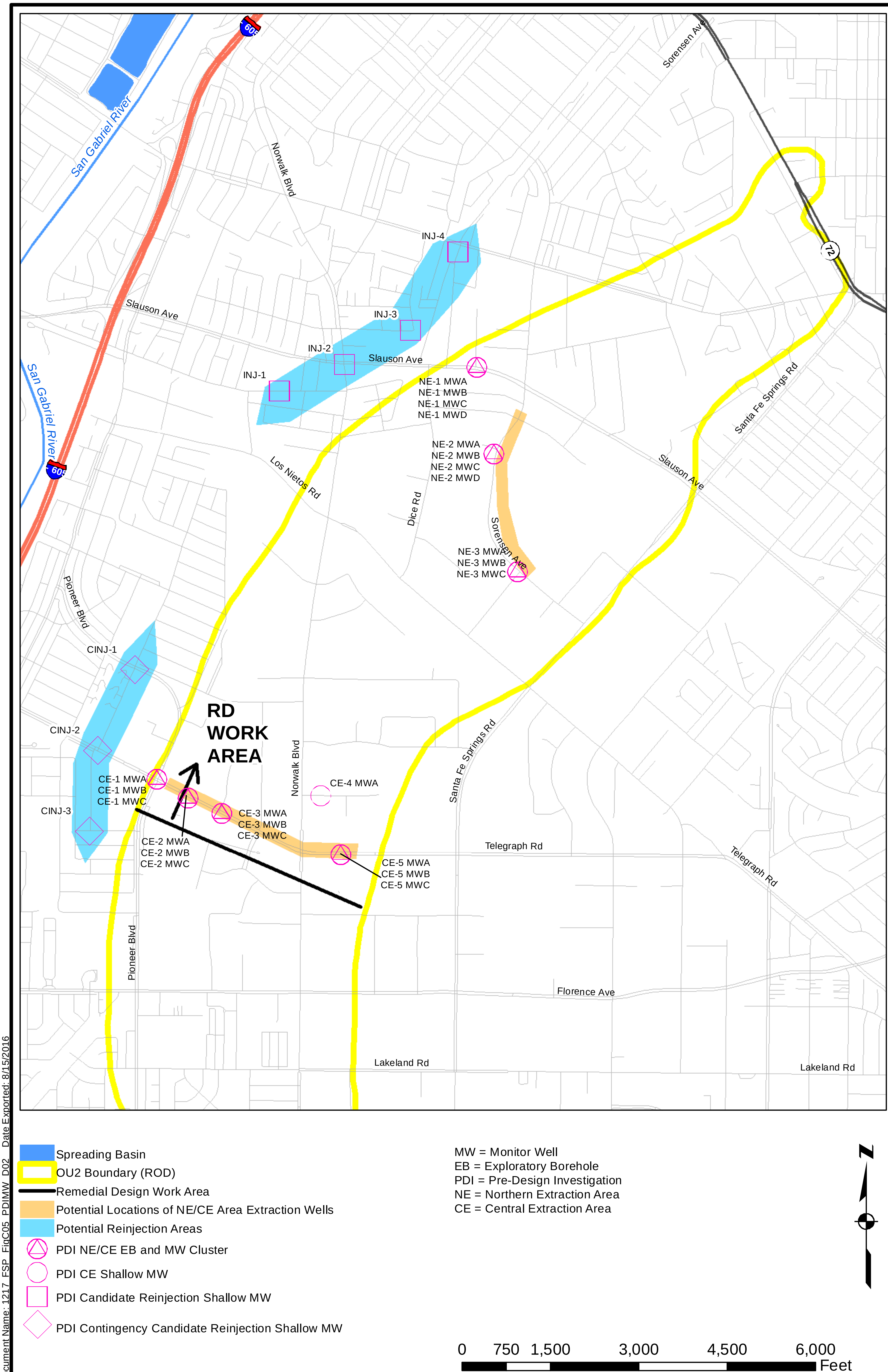

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FIGURE C-5. PRE-DESIGN INVESTIGATION GROUNDWATER MONITOR WELL LOCATIONS

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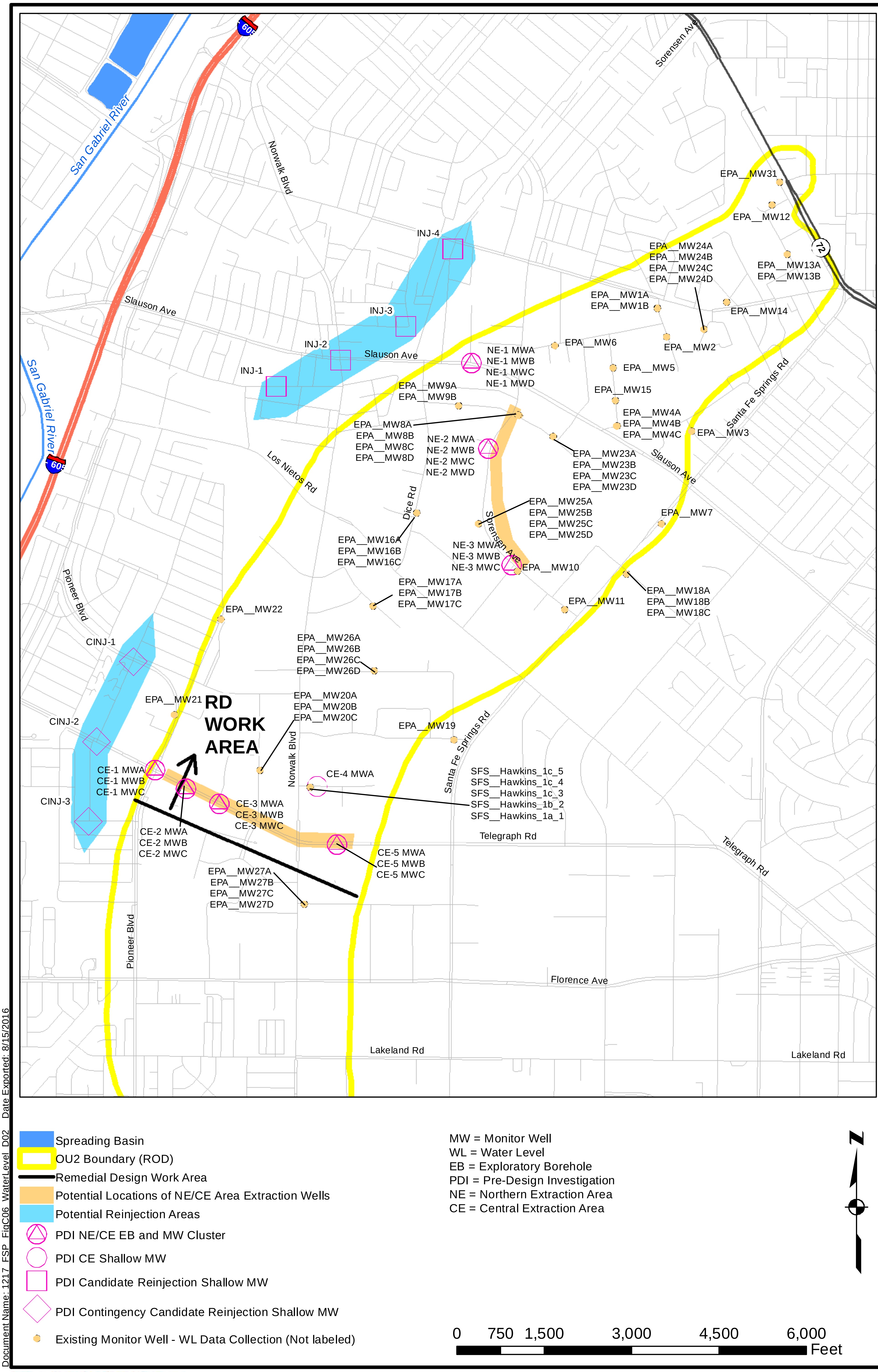

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FIGURE C-6. PRE-DESIGN INVESTIGATION WATER LEVEL MONITORING LOCATIONS

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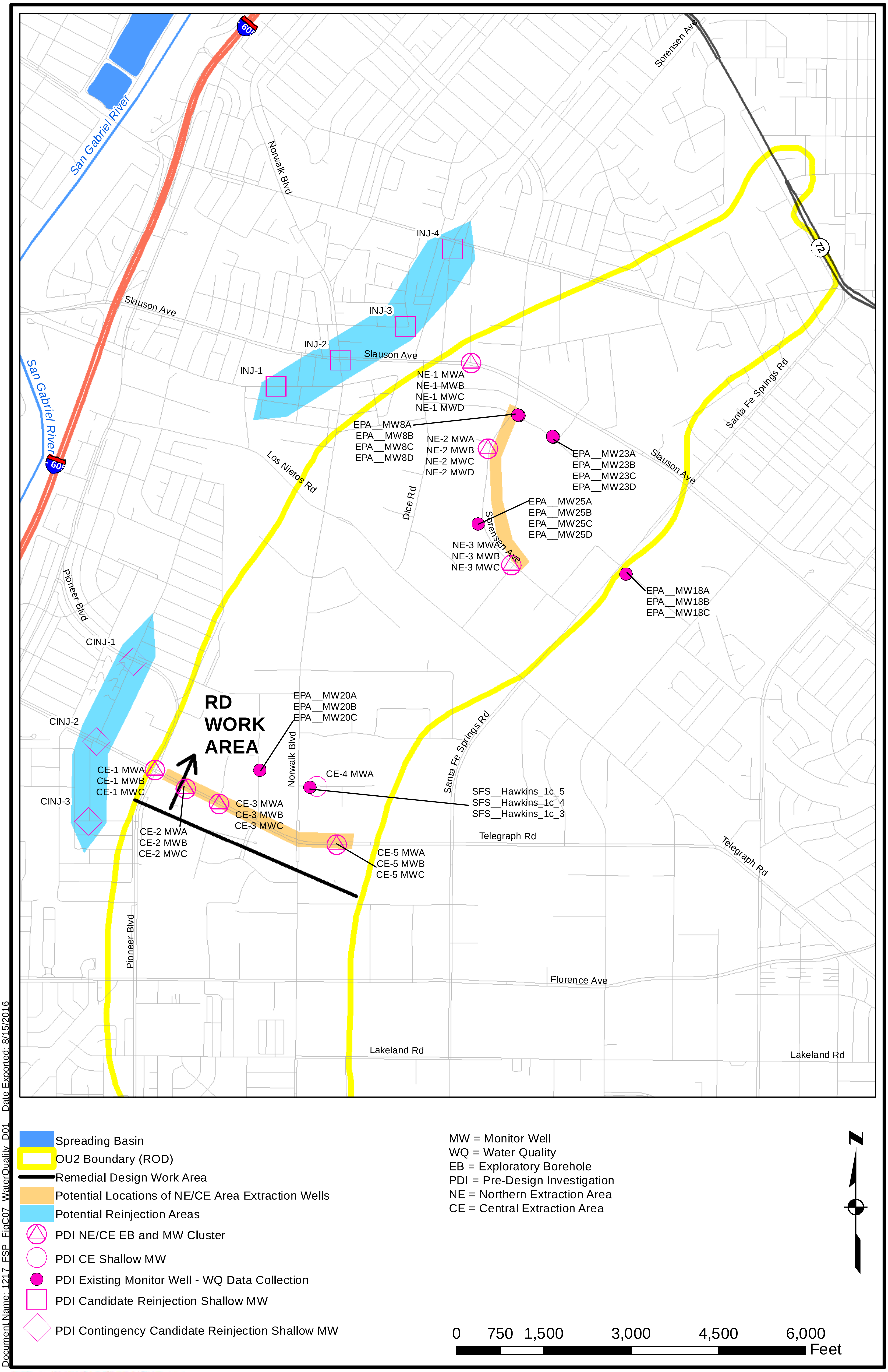

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FIGURE C-7. PRE-DESIGN INVESTIGATION GROUNDWATER SAMPLE LOCATIONS

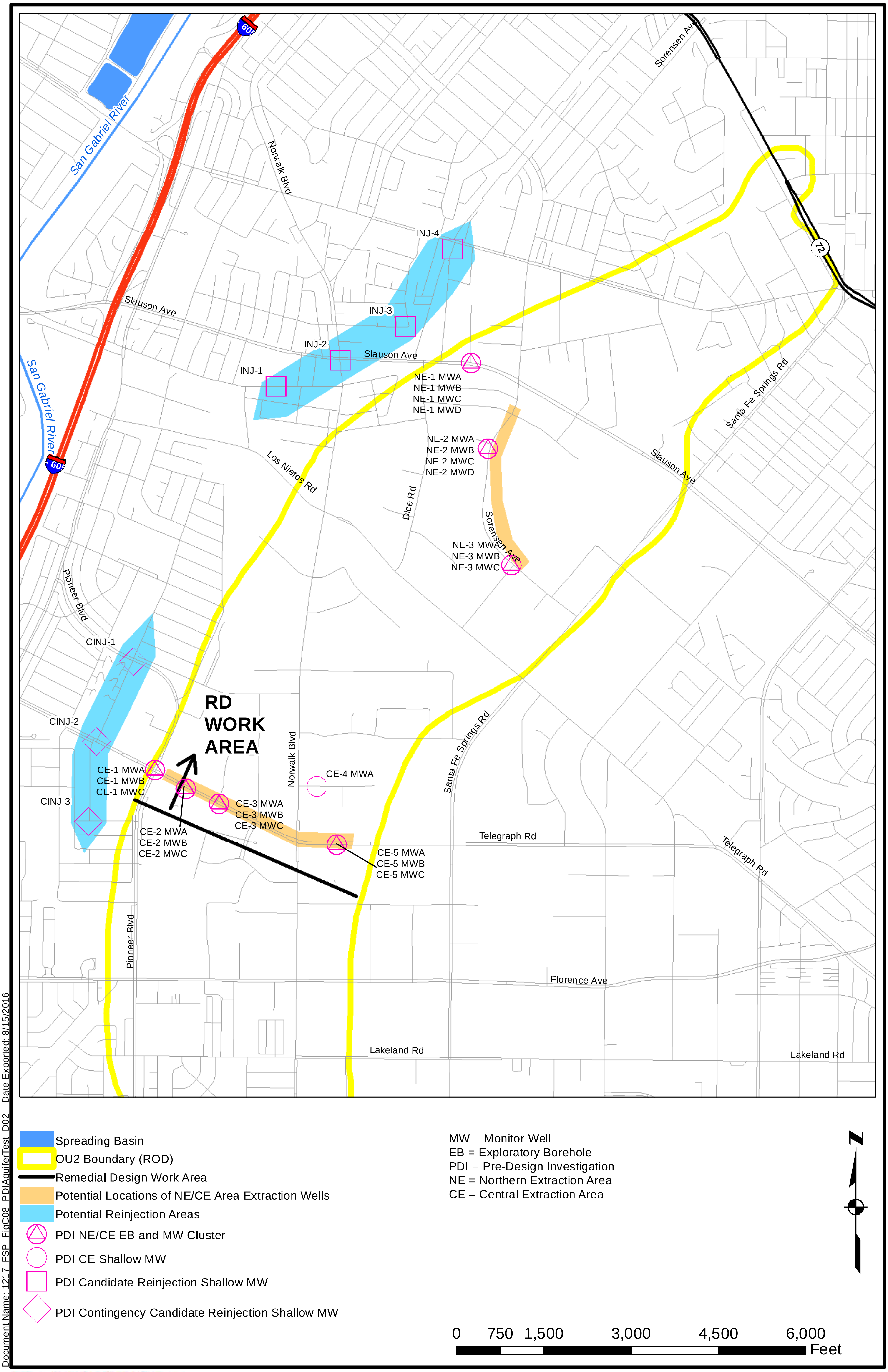

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FIGURE C-8. PRE-DESIGN INVESTIGATION AQUIFER TEST LOCATIONS

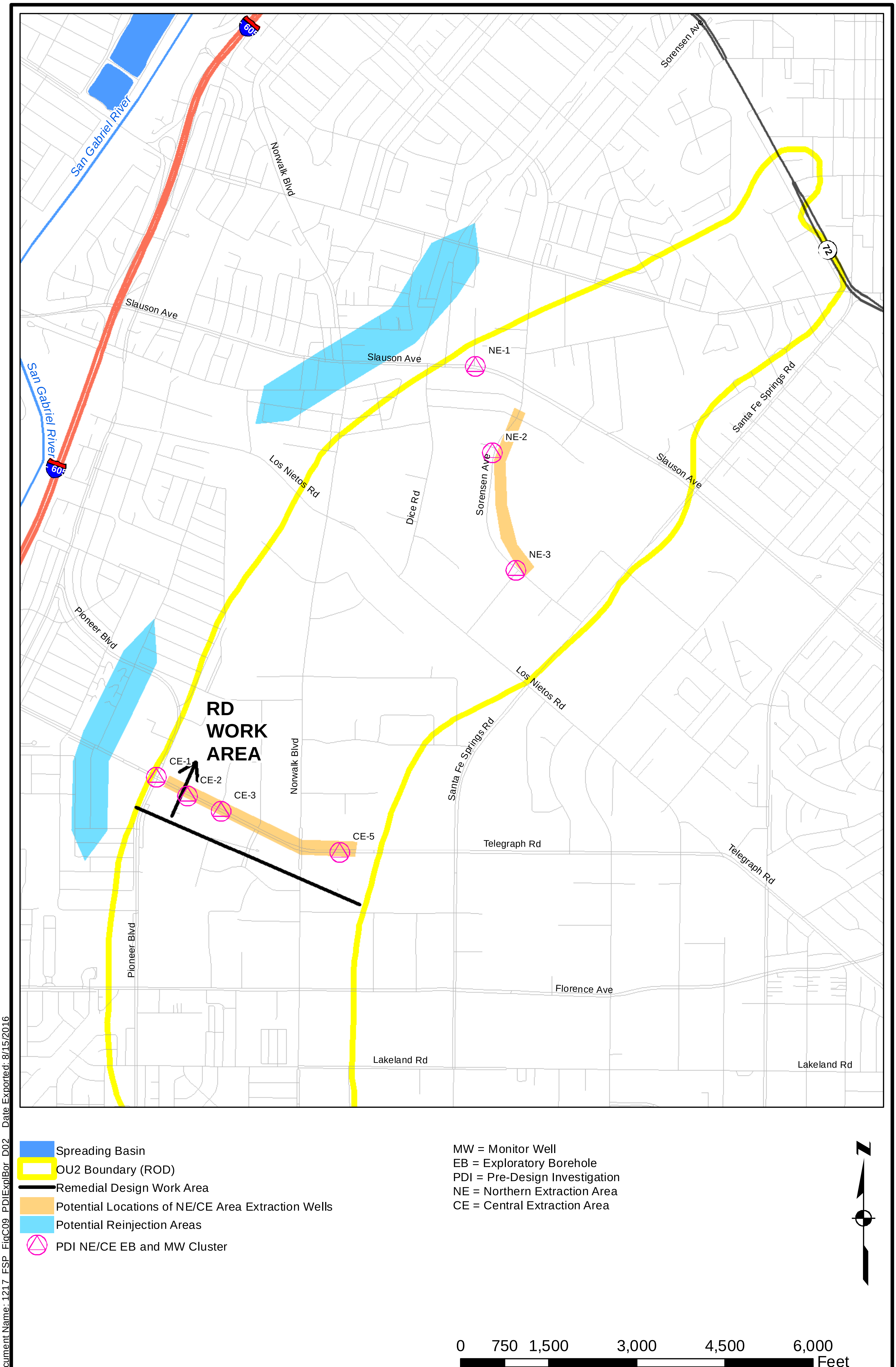

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FIGURE C-9. PRE-DESIGN INVESTIGATION EXPLORATORY BOREHOLE LOCATIONS

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ATTACHMENT C-1

FIELD STANDARD OPERATING PROCEDURES

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ATTACHMENT C-1

FIELD STANDARD OPERATING PROCEDURES

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LIST OF ACRONYMS/ABBREVIATIONS/COMMON TERMS

2010 FS	August 2010 OU2 Feasibility Study
2010 RI	August 2010 OU2 Remedial Investigation
2011 ROD	OU2 Interim Action Record of Decision, dated September 20, 2011
2016 CD	Consent Decree lodged April 20, 2016 covering Operable Unit 2 at the Omega Chemical Corporation Superfund Site
AOP	Advanced oxidation process
ASTM	American Society for Testing and Materials
bgs	Below ground surface
bls	Below land surface
CDM Smith	CDM Smith, Inc.
CDWR	California Department of Water Resources
CE Area	Central extraction area (The location of the CE area is depicted in the 2016 CD, Appendix C as the area between the NE and Telegraph Road.)
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COCs	Chemicals of Concern
COPCs	Chemicals of Potential Concern
Day	Day means a calendar day unless expressly stated to be a working day. A working day is a day other than a Saturday, Sunday or federal or state holiday.
DO	Dissolved oxygen
DTSC	California Department of Toxic Substances Control
EC	Electrical conductivity
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Differences
FSP	Field Sampling Plan

LIST OF ACRONYMS/ABBREVIATIONS/COMMON TERMS (continued)

Geosyntec	Geosyntec Consultants
gpm	Gallons per minute
H+A	Hargis + Associates, Inc.
HHRA	Human Health Risk Assessment
ICIAP	Institutional Controls Implementation and Assurance Plan
ICs	Institutional Controls. (ICs are non-engineering controls that will supplement engineering controls to prevent or limit potential exposure to hazardous substances, pollutants, or contaminants at the Site related to the Work and to ensure that the portion of the ROD applicable to the Work is effective.)
ID	Inner diameter
IDW	Investigation-derived wastes
IX	Ion exchange
Key Treatment Constituents	Treatment constituents that may require treatment to meet discharge requirements associated with end-use (reinjection, spreading basin, reclaim). The Key Treatment Constituents are considered during the RD based on end use.
LE Area	Leading Edge Area of OU2 is the area in the 2016 CD, Appendix C that is south of the CE Area
Main COCs	13 COCs identified in the ROD as "main COCs" and listed in Table X. Includes eleven VOCs, 1,4-dioxane, and hexavalent chromium. The Main COCs are included in the COC list for the RD.
MCLs	Maximum Contaminant Levels (EPA and California)
ml	Milliliter
ml/min	Milliliters per minute
msl	Mean sea level
NE Area	Northern extraction area (The location of the NE area is depicted in Appendix C of the 2016 CD as an area north of the CE)

LIST OF ACRONYMS/ABBREVIATIONS/COMMON TERMS (continued)

NE/CE Area	A portion of the area of the groundwater contamination identified by EPA as OU2 in its 2011 ROD. The NE/CE Area is bounded by the OU2 boundary as depicted in the 2016 CD, Appendix C and the area north of Telegraph Road. It includes the NE and CE areas as depicted in the ROD as well as the northern portion of the LE area as depicted in the ROD.
NF	Nanofiltration
NL	Notification Level, California State Water Resources Control Board
O&M	Operations and Maintenance
OFRP	Oil Field Reclamation Project
Omega Property	The property formally owned by the Omega Chemical Corporation, encompassing approximately one acre, located at 12504 and 12512 East Whittier Blvd, Whittier, California. OU1 and OU3 are addressing soil, groundwater, and soil vapor source control at the Omega Property.
ORP	Oxidation-reduction potential
OU	Operable Unit, a discrete action that comprises an incremental step in the remediation of a contaminated site.
OU2	Operable Unit 2, the contamination in groundwater generally downgradient of Omega Property, much of which has commingled with chemicals released at other locations into a regional plume containing multiple contaminants which, when considered in total, is more than four miles long and one mile wide. The OU2 boundary is depicted in the 2016 CD, Appendix C.
PC	Project Coordinator, an individual who represents the SWDs and is responsible for overall coordination of the Work.
PDI	Pre-Design Investigation
PDIWP	Pre-Design Investigation Work Plan
Performance Standards	The cleanup levels and other measures of achievement of the remedial action objectives, as set forth in the SOW, Paragraph 1.3(c).

LIST OF ACRONYMS/ABBREVIATIONS/COMMON TERMS (continued)

PID	Photoionization detector
PRPs	Potentially Responsible Parties
PVC	Polyvinyl chloride
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RA	Remedial Action (Remedial Action shall mean all activities Settling Defendants are required to perform under the 2016 CD to implement the 2011 ROD, in accordance with the SOW, the final approved RD submission, the approved RA Work Plan and other plans approved by EPA, including the ICIAP, until the Performance Standards are met, and excluding performance of the RD, O&M, and the activities required under the Retention of Records section of the 2016 CD.)
RAOs	Remedial Action Objectives
RAWP	Remedial Action Work Plan
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design (Remedial Design means those activities to be undertaken by Settling Work Defendants to develop the final plans and specifications for the Remedial Action pursuant to the Remedial Design Work Plan.)
RDWA	Remedial Design Work Area. (The RDWA consists of the NE/CE Area and includes potential treated water end use locations that may be adjacent to or outside of OU2.)
RDWP	Remedial Design Work Plan
RO	Reverse osmosis
RWQCB-LA	Regional Water Quality Control Board, Los Angeles Region

LIST OF ACRONYMS/ABBREVIATIONS/COMMON TERMS (continued)

Site	Omega Chemical Corporation Superfund Site, originally listed on the National Priorities List on January 19, 1999, which is located in Los Angeles County, California, and includes the contamination being addressed by multiple Operable Units.
SOP(s)	Standard Operating Procedure(s)
SOW	Statement of Work, Appendix B to the 2016 CD.
STLC	Soluble Threshold Limit Concentration
Supervising Contractor	The entity selected by SWDs to oversee field work.
SVOCs	Semivolatile organic compounds
SWDs	Settling Work Defendants, as identified in Appendix E to the 2016 CD. SWDs include the McKesson Corporation and OPOG (Omega Chemical Corporation Superfund Site Potentially Responsible Party Organized Group).
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total dissolved solids
TTLC	Total Threshold Limit Concentration
USGS	United States Geological Survey
USCS	Unified Soil Classification System
VOCs	Volatile organic compounds
WAMP	Work Area Monitoring Plan
Waste Material	Shall mean (1) any "hazardous substance" under Section 101(14) of CERCLA, 42 U.S.C. § 9601(14); (2) any pollutant or contaminant under Section 101(33), 42 U.S.C. § 9601(33); (3) any "solid waste" under Section 1004(27) of RCRA, 42 U.S.C. § 6903(27); or as any of the foregoing terms are defined under any appropriate or applicable provisions of California law.
WDR	Waste Discharge Requirement

LIST OF ACRONYMS/ABBREVIATIONS/COMMON TERMS (continued)

Work	All activities and obligations the SWDs are required to perform under the 2016 CD, except the activities required under the Retention of Records section of the 2016 CD.
Work Area	The portions of OU2 that are the subject of Work under the 2016 CD and the SOW.
Waste Material	Shall mean (1) any "hazardous substance" under Section 101(14) of CERCLA, 42 U.S.C. § 9601(14); (2) any pollutant or contaminant under Section 101(33), 42 U.S.C. § 9601(33); (3) any "solid waste" under Section 1004(27) of RCRA, 42 U.S.C. § 6903(27); or as any of the foregoing terms are defined under any appropriate or applicable provisions of California law.

LIST OF ADDITIONAL ACRONYMS AND ABBREVIATIONS

1,1-DCA	1,1-Dichloroethane
1,1-DCE	1,1-Dichloroethene
1,1,2-TCA	1,1,2-Trichloroethane
1,2-DCA	1,2-Dichloroethane
1,2,3-TCP	1,2,3-Trichloropropane
cis-1,2-DCE	cis-1,2-Dichloroethane
Freon 11	Trichlorofluoromethane
Freon 113	1,1,2-Trichloro-1,2,2-trifluorethane
NDMA	N-Nitrosodimethylamine
PCE	Tetrachloroethene, perchloroethene
TCE	Trichloroethene

ATTACHMENT C-1

FIELD STANDARD OPERATING PROCEDURES

1. INTRODUCTION

Field activities covered by the Field Sampling Plan (FSP) include planned and contingent tasks. Planned field activities to be conducted under this FSP include the following, although they are not necessarily listed in the order they will be performed:

- Drilling
- Lithologic Logging
- Core Sample Collection
- Geophysical Logging
- Monitor Well Construction
- Well Surveys
- Aquifer Testing
- Water Level Measurement
- Water Quality Parameters Measurement
- Groundwater Sample Collection
- Handling, Storage, Characterization, and Disposal of Investigation-Derived Wastes (IDW)

The following contingent task has been identified, and will be conducted, if required, under provisions of the FSP:

- Injection Testing

The following sections describe the field Standard Operating Procedures (SOPs) previously outlined.

"The Site", as used in these SOPs, refers to the Work Area as outlined in the Statement of Work, Appendix B of the Consent Decree for Operable Unit 2 at the Omega Chemical Corporation Superfund Site (U.S. Environmental Protection Agency [EPA], 2016).

2. DRILLING

2.1 General Statement

Boreholes drilled for the placement of monitor wells will also be utilized to characterize subsurface conditions at and in the vicinity of the Site. For monitor wells constructed using mud rotary techniques, a suite of geophysical logs will be obtained in deep monitor well borings. Monitor wells will be constructed after lithologic and, if required, geophysical data have been obtained. Monitor well drilling, lithologic logging, core sampling, and well construction will be conducted under the supervision of a California Professional Geologist (Supervising Professional Geologist).

This SOP for drilling will also apply to drilling of any pilot injection wells installed at the Site.

2.2 Objectives

Borings will be drilled in order to define the lithology and characteristics of geologic materials and to delineate the hydrogeologic conditions at and in the vicinity of the Site. SOPs have been prepared for lithologic logging of cuttings and core samples obtained from well borings (Sections 3.0 and 4.0). Geophysical logs obtained in well borings will be used to evaluate lithology and assist in the design of monitor well clusters (Section 5.0). SOPs have been prepared for monitor well construction (Section 6.0). Objectives for each of these data collection activities associated with drilling are specified in the respective Section describing SOPs for those activities.

2.3 Equipment and/or Instrumentation

Well borings will be drilled using mud rotary, sonic, or hollow-stem auger drilling methods, as appropriate. For monitor wells constructed using mud rotary techniques, a suite of geophysical logs will be obtained prior to monitor well construction. SOPs for geophysical logging have been prepared (Section 5.0).

2.4 Preparation

A qualified driller will be selected to drill the well borings. A qualified driller will have appropriate equipment capabilities, a California C-57 license, experience on similar projects, and documentation of health and safety training. This experience requirement shall apply both to the individual driller in the field and to the drilling company as a whole.

Prior to entering the field, authorized personnel will contact property owners and applicable agencies to obtain and comply with regulatory requirements regarding permits, access, drilling, and underground utility clearance.

2.5 Procedures

Well borings will be drilled using mud rotary, sonic, or hollow-stem auger drilling methods, as appropriate. Soil samples may be collected at preselected depths, or by continuous core over a preselected interval (Section 4.0). Upon reaching total depth, and after lithologic and, if required, geophysical logging have been completed, the boring will be converted to a monitor well (Section 6.0). It may be necessary to enlarge the borehole by reaming in order to accommodate the well casing and other well construction materials in accordance with design requirements.

2.6 Equipment Decontamination and Waste Disposal

All downhole drilling equipment will be steam cleaned and maintained in a clean condition prior to commencing drilling operations at each drilling location.

All materials generated during drilling activities will be contained, labeled, and temporarily stored in 55-gallon drums, rolloff bins, and/or Baker-type portable tanks until an appropriate disposal option is determined. This includes all drilling fluid, drill cuttings, and wash and rinse water. An SOP for handling, storage, characterization, and disposal of IDW has been prepared (Section 13.0).

2.7 Documentation

A log of conditions encountered during drilling will be maintained by an experienced field staff. The log will include lithologic and hydrogeologic descriptions, as well as notations on drilling characteristics and conditions encountered during drilling. Field lithologic descriptions will be based on examination of drill cuttings and/or undisturbed core samples with consideration of impacts of the drilling process on cuttings. All logging will be conducted by experienced field staff supervised by the Supervising Professional Geologist. Lithologic logs will be prepared according to SOPs (Section 3.0). Documentation will be compiled for each boring and will include the following:

- Lithologic log of drill cutting and core samples in a field notebook. Lithologic descriptions for soil will follow the Unified Soil Classification System (USCS) procedures (American Society for Testing and Materials [ASTM], 2009).

- Field notes compiled by the on-site field staff during drilling operations. The field notebook will be the responsibility of the field team leader.
- Geophysical logs, if applicable.
- Photographs, if available.

Final logs will be prepared based on all available information including core samples, drill cuttings, and geophysical logs. Drill cutting samples will be retained until the lithologic log is finalized. Core samples will be retained until the report documenting the respective work has been finalized and accepted by EPA.

2.8 Quality Assurance

Quality assurance (QA) during drilling, sampling, and logging of boreholes will be accomplished by following this SOP. In addition, the Supervising Professional Geologist will review all lithologic logs and drilling documentation throughout drilling operations to ensure conformity with this SOP.

3. LITHOLOGIC LOGGING

3.1 General Statement

A log of the conditions encountered during drilling of monitor well borings will be maintained. The log will include lithologic and hydrogeologic descriptions along with notations on drilling activities and conditions encountered during drilling. Lithologic logging will be conducted by experienced field staff under the direction of a California Professional Geologist (Supervising Professional Geologist).

This SOP for lithologic logging will also apply to drilling of borings for any pilot injection wells installed at the Site.

3.2 Objectives

Lithologic logs compiled during drilling activities will be used for various purposes. Their primary use will be for the interpretation of subsurface geologic conditions and for monitor well and pilot injection well design. They may also be used in construction of interpretive maps or diagrams such as geologic maps, geologic cross sections, fence diagrams, structural contour maps, and isopach maps. Information recorded as part of the lithologic log will also be important in the interpretation of hydrogeologic characteristics of the soil/rock being logged, such as the ability of these materials to transmit water and adsorb and transmit chemical constituents.

3.3 Equipment and/or Instrumentation

Equipment used as part of lithologic logging may include any or all of the following: hand lens, dropper bottle containing dilute hydrochloric acid, Munsell color chart, sand size chart, sample collection bags, cuttings trays, wire mesh sieves, photoionization detector (PID) to monitor organic vapor, and pocket knife. Reference materials such as the USCS (ASTM D2488-09a) (ASTM, 2009) will be used for soil characterization; other references are available as well for description of soil/rock (American Geologic Institute Data Sheets for Field Geology [Walker and Cohen, 2009], Manual of Field Geology [Compton, 1962], or Earth Manual [U.S. Department of Interior, Bureau of Reclamation, 1998]).

3.4 Preparation

Essential field equipment and supplies will be ordered prior to commencing lithologic logging. Available references relating to the Site vicinity such as lithologic logs, geologic reports, and other information from previous Site assessments should be reviewed to evaluate the nature of the study area geology. Review health and safety procedures with field personnel.

3.5 Procedures

A lithologic log will be compiled during drilling of monitor well borings. The following procedures will be used during lithologic logging activities:

- Describe the soil/rock sample or drill cuttings and record in field notebook. Take into account alterations caused by the sampling or drilling process.
- Note unusual drilling conditions or rig behavior.

The following procedures will be used for lithologic description of drill cutting samples and/or soil samples collected using coring methods, if applicable (Section 4.0):

- Core Recovery:
  - Record core recovery - ratio of the length of core recovered to the total length of the core run.
- Textural Classification of Soil:
  - Record the approximate ratio of the following grain size fractions present in the sample: gravel, sand, silt, and clay. The size limits for each fraction will be in accordance with the USCS (ASTM D2488-09a) (ASTM, 2009). Estimate and record the predominant grain size(s) present within the gravel and sand fractions in the sample.
  - Provide textural classification name for the soil/sediment and classify the soil/sediment using the USCS. The root of the name is determined by the highest percentage of gravel, sand, silt, or clay fractions. The modifying terms are based on the relative percentage of the other major size fractions in the sample. A major size fraction is defined as a textural fraction that constitutes 30 percent or more of the sample, by volume. For example, a sample containing 90 percent sand and 10 percent silt would be classified as “sand with silt”. Record the appropriate USCS classification on the lithologic log form.
- Color:
  - Compare sample to Munsell color chart and provide hue and chroma values for moist soil samples; if the color was determined based on a dry sample, indicate in log. Record the Munsell color descriptor.

- Moisture Content:
  - For soil/sediment samples collected using drilling methods that do not involve introduction of fluids, estimate relative moisture content using the terms "dry", "moist", and "wet".
- Consistency:
  - Estimate the consistency of the sample based both on examination of samples and on observation of the drilling characteristics of the soil/sediment. Consistency descriptors for fine-grained soils/sediments are: very soft, soft, firm, hard, and very hard. Use of these descriptors is inappropriate for soils with significant amounts of gravel.
- Plasticity:
  - Determine the degree of plasticity for fine-grained lithologic samples. Plasticity is the property in which a soil/sediment can be rapidly deformed or molded without rebounding elastically, changing volume, cracking, or crumbling (ASTM, 2009). Plasticity descriptors are: nonplastic, low plasticity, medium plasticity, and high plasticity.
- Grading:
  - Estimate the degree of grading, or overall grain size distribution, of soil/sediment samples that consist predominantly of sand-sized or larger particles. Designate by using one of the following descriptors: poorly graded or well graded. The descriptor "well graded" applies to soils/sediments in which there is a good representation of the continuum of particle sizes. The descriptor "poorly graded" applies to soils/sediments in which most particles are about the same size, or if it has a wide range of particle sizes with some intermediate sizes obviously missing (gap graded or skip graded).
- Angularity:
  - Estimate the predominant angularity categories for the sand and gravel size fractions according to the roundness scale (Walker and Cohen, 2009). The roundness categories are: angular, subangular, subrounded, and rounded. The field staff will record in the field notebook actions of drilling bits or auger flights that may be responsible for increasing the angularity of the sand or gravel size fractions in the sample, if applicable.
- Miscellaneous Properties:
  - Additional properties should be reported if noted in the soil/sediment sample (ASTM, 2009). These properties include the following: mineralogic

composition; degree of iron or manganese staining of coarse fraction; reactance with dilute hydrochloric acid; odor; other physical properties, including maximum particle size, particle shape, cementation, dry strength; dilatancy, toughness, soil structure, and fracture spacing and width, if applicable; orientation and coatings on fractures, if applicable; presence of man-made, animal, or plant material; and organic vapor readings determined using equipment such as a PID. See ASTM D2488-09a for additional details regarding soil description.

3.6 Documentation

The field staff will compile lithologic logging descriptions and observations made during drilling activities in the field notebook and the lithologic log. The field notebook will be the responsibility of the field team leader.

A project-specific lithologic log form has been developed (Table SOP-1). In addition to lithologic data, the lithologic log form includes:

- Project name
- Date(s)
- Boring identifier
- Boring location
- Geologist's name
- Drilling company's name
- Drill rig operator's name
- Drilling method
- Weather conditions
- Space for remarks and comments

Final lithologic logs will be prepared based on all available information. A copy of the field notebook entries for monitor well borings will be maintained in the field for reference purposes. One set of the completed documentation forms will also be maintained in the field for reference purposes. The original set of notes and forms will be filed in the project files.

3.7 Quality Assurance

QA during lithologic logging activities will be accomplished by following this SOP. In addition, the Supervising Professional Geologist will review all lithologic logs and drilling documentation throughout drilling operations to ensure conformity with this SOP.

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4. CORE SAMPLE COLLECTION

4.1 General Statement

Core samples may be collected from well borings. Core samples could be depth-discrete or continuous core, as appropriate. Borings will be drilled using hollow-stem auger, mud rotary, or sonic drilling methods unless conditions warrant another method of construction. For hollow-stem auger methods, core samples would be collected using a split-spoon sampler. For mud rotary methods, core samples would be collected using a steel core sampler inserted into a wireline core barrel. If sonic drilling methods are used, continuous core will be extruded as each section of hollow drill rod is advanced, but a split-spoon core barrel or similar device could be used when collecting a discrete core sample for laboratory analysis. Other coring devices could be utilized if sufficient core recovery is not achieved using the wireline core system. Monitor well drilling, lithologic logging, and soil sampling will be conducted under the supervision of a California Professional Geologist (Supervising Professional Geologist).

4.2 Objectives

Core samples may be collected from well borings and could be tested and analyzed to determine physical characteristics of the soil matrix within the vicinity of the Site. Soil samples may also be analyzed for engineering parameters including grain size distribution, bulk density, porosity, and vertical hydraulic conductivity using various ASTM or other appropriate methods. The resultant data would be used to characterize lithologic, physical, and hydrogeologic parameters of the subsurface at the respective monitor well locations. These parameters would be used for the interpretation of subsurface geologic conditions and/or for monitor well design. They may also be used in construction of interpretive maps or diagrams such as geologic maps, geologic cross sections, fence diagrams, structural contour maps, and isopach maps. Information obtained from core samples could also be important in the interpretation of hydrogeologic characteristics of the cored soil/rock, such as the ability of these materials to transmit water, and adsorb and transmit chemical constituents.

4.3 Equipment and/or Instrumentation

Equipment used during core sample collection may include a core sampler advanced ahead of the core barrel bit, or other similar coring device, using the hollow auger, rotary, or sonic drill.

4.4 Preparation

The following procedures will be performed in preparation for core sample collection:

- Review project objectives with field personnel and identify locations to be drilled.
- Review sampling intervals, sampling equipment and supplies, time of sampling, and schedule of analyses to be performed.
- Review health and safety procedures with field personnel.
- Obtain underground utility clearance.
- Review appropriate permits, insurance requirements, contractual requirements, and Site access procedures, if applicable.
- Inform laboratory of expected sample shipments, if applicable.
- Clean core samplers according to procedures outlined in Section 4.7.

4.5 Procedures

The following procedures will be performed during core sample collection for analysis of physical properties:

- WIRELINE PROCEDURE: Remove wireline bit from borehole. Attach clean sampler to wireline core barrel. Insert sampler into borehole and advance the sampler into the formation by using the rotary drill. Observe and record drilling or penetration characteristics while the sampler is being advanced.
- PITCHER TUBE SAMPLER: Remove rotary drill bit from borehole. Attach clean sampler to drill rod, insert sampler into borehole, and advance the sampler into the formation by using the rotary drill. Observe and record drilling or penetration characteristics while the sampler is being advanced.
- SPLIT-SPOON SAMPLER: Attach clean standard or California modified split-spoon sampler to hammer assembly if using hollow auger, or to drill rod if using sonic drilling. If samples are being collected for laboratory analyses, line the split-spoon sampler with clean brass or stainless steel sleeves prior to attaching sampler to hammer assembly or drill rod. Insert sampler into borehole and advance the sampler into the formation using the hammer of the auger rig, or by pushing/vibrating with the sonic rig. Observe and record drilling or penetration characteristics while the sampler is being advanced.

- SONIC DRILLING PROCEDURE: Continuous soil core will be extruded in the course of the sonic drilling process. For core samples to be submitted for laboratory analysis, remove the sonic drive bit from the borehole. Attach clean sample barrel to drill rod, insert sampler into borehole, and advance the sampler into the formation by pushing or vibrating with the sonic rig.
- After the sampler is retrieved, carefully remove and examine the core. Determine the percent recovery, place the core in a core box, and label the top and bottom of the core with the appropriate depth intervals.
- Selected core samples may be sent for testing of physical properties. Secure caps with custody seals and attach sample label (Figure SOP-1). Place each sample in a resealable plastic bag.
- Complete appropriate chain-of-custody records (Table SOP-2).
- Package and store samples, and transport or transmit to laboratory within 48 hours after sample collection, or sooner if respective analyses require holding/preparation times that are shorter.

4.6 Sample Containers, Preservation, and Transmittal

A split-spoon sampler or other steel core barrel or similar sampling system will be used to collect core samples for testing of physical properties. Handling protocols for core sample containers are referenced in the companion FSP. Core samples collected for testing of physical properties will be stored and transported to the laboratory without ice in sealed containers containing a sample transmittal letter and chain-of-custody form.

4.7 Equipment Decontamination and Disposal

Prior to the collection of core samples, the downhole samplers will be washed with nonphosphate detergent, followed by tap water rinse, and then a final, distilled water rinse. Excess cuttings generated during the drilling of monitor wells and collection of core samples will be contained and properly disposed.

4.8 Documentation

Documentation of the core sampling activities will include records of sampling events in the field notebook, sample identification documents, and transmittal letters to the laboratory.

The field notebook will be the responsibility of the field team leader. All entries will be signed and dated, and the field notebook will be kept as a permanent record. The following information will be entered into the field notebook each time a sample for engineering properties is collected:

- Sample location/identifier
- Depth at which sample was collected
- Date and time sample was collected
- Analyses to be performed
- Sample lithologic description
- Any other pertinent information, including any difficulties in sampling or unusual drilling occurrences

Sample identification documents will be prepared so that sample identification and chain-of-custody are maintained, and sample disposition controlled. The sample identification documents to be used are:

- Sample identification labels
- Chain-of-custody record and analyses request form

Standard sample identification labels, and chain-of-custody and analysis request forms will be used to record all information (Table SOP-2; Figure SOP-1). Sample documentation forms and labels will be completed with waterproof ink. Information on the sample labels will be protected from water with clear label protection tape. The sample documentation forms will accompany the samples to the laboratory. Copies of the chain-of-custody and analysis request forms will be retained by the field staff collecting the samples and sent directly to the Project QA Manager.

Preprinted adhesive sample labels will be secured to the sample containers by field personnel. The following information will be recorded on the sample label:

- Sample location/identifier
- Depth at which sample was collected
- Date and time sample was collected
- Analyses to be performed
- Project name and number
- Sampler's initials

- Any special instructions to laboratory personnel

Official custody of samples will be maintained and documented from the time of sample collection until the receipt and approval of analytical results. The chain-of-custody record is the document that records the transfer of sample custody. The chain-of-custody record also serves to cross reference the sample identifier assigned by the Project QA Manager for the project with the sample identifier assigned by the laboratory. The chain-of-custody record includes the following information:

- Sample location/identifier
- Project code
- Sampling date
- Sampling personnel
- Shipping method and date
- Sample description
- Sample volume
- Number of containers
- Sample destination
- Preservatives used
- Analyses to be performed
- Special handling procedures
- The identity of personnel relinquishing and accepting custody of the samples.

The sampling personnel will be responsible for the samples and will sign the chain-of-custody record to document sample transferal or transport. Samples will be packaged in sealed containers for transport and dispatched to the appropriate laboratory for analysis with a separate chain-of-custody record and analysis request form accompanying each shipment. During transport, samples will be accompanied by the chain-of-custody documentation.

Once received at the laboratory, laboratory custody procedures apply. It is the laboratory's responsibility to acknowledge receipt of samples and verify that the containers have not been opened or damaged. It is also the laboratory's responsibility to maintain custody and sample tracking records throughout sample preparation and analysis.

4.9 Quality Assurance

QA during core sample collection activities will be accomplished by following this SOP. In addition, the Supervising Professional Geologist will review the field notebook, sample identification documents, and transmittal letters to the laboratory throughout the core sample collection activities to ensure conformity with this SOP. The Project QA Manager will also review sample identification documents and chain-of-custody documentation to ensure conformity with these aspects of this SOP.

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5. GEOPHYSICAL LOGGING

5.1 General Statement

Following drilling of monitor well borings to total depth, borehole geophysical logs may be obtained to provide data for evaluating lithology, groundwater conditions, and borehole conditions. Geophysical logs may include the following: spontaneous potential, 16-inch normal resistivity, 64-inch normal resistivity, lateralog-3, gamma ray, and caliper. Additional geophysical logs, such as borehole deviation or downhole video, may be obtained depending on project requirements. Geophysical logging will be conducted under the supervision of a California Professional Geologist (Supervising Professional Geologist).

5.2 Objectives

Geophysical logs may be obtained to define the lithology and characteristics of geologic materials, and to characterize the subsurface hydrogeology. Geophysical data would also be used to assist in the selection of screened intervals and other aspects of monitor well design such as the placement of filter pack and annular seals.

The objectives of the geophysical logging task are to provide data that are of sufficient quality to support decisions made during Work Area activities and that are representative of actual Site conditions. The objectives of this task will be achieved by implementing quality control (QC) procedures for geophysical logging, by conforming to the procedures specified in the following sections, and by conforming to specific QA objectives for geophysical logging activities.

5.3 Equipment and/or Instrumentation

Borehole geophysical logging will be performed by a qualified geophysical subcontractor. Equipment required will be based on the suite of logs selected. A hard copy of geophysical logs will be recorded on paper. Geophysical logs will also be stored digitally. The logging equipment provided should be capable of being calibrated in the field.

Successful borehole geophysical logging operations depend on adequate planning and close supervision to ensure that equipment is operated properly, the recorded data are accurate, and the log is easily interpretable. Copies of this SOP will be kept on Site by the field staff and will be referred to before, during, and after geophysical logging, as needed.

5.4 Preparation

The following procedures will be performed in preparation for geophysical logging:

- Review health and safety procedures with field personnel and contracted logging service company.
- Review appropriate insurance requirements, contractual requirements, and Site access procedures, if applicable.
- Notify the contracted logging service company at least 24 hours before the anticipated logging period. Estimate required lead time for dispatching the truck. Provide the following information:
  - Company name as it appears on the log header.
  - Consultant's name; name of consultant representative, usually on-Site field team leader; and local office telephone number.
  - Monitor well name/number and location.
  - Explicit directions to Site and information on Site access. If access is controlled, arrange a specific time and location to meet the logging truck outside the restricted area.
  - Approximate time borehole will be ready for logging and the time required for conditioning the borehole prior to logging.
  - Approximate total depth of borehole in feet below land surface (bls) and approximate ground level elevation in feet mean sea level.
  - Borehole dimensions.
  - Geophysical logs to be obtained may include:
    - spontaneous potential;
    - 16-inch normal resistivity, 64-inch normal resistivity, lateralog-3;
    - caliper; and
    - gamma ray.
  - Notification of potential health and safety hazards.
  - Confirmation and documentation of logging tool calibration.
  - Name of, and request for, logging unit and operator used previously on the project.

- As the borehole nears completion, contact the logging service to confirm dispatch of the logging truck. Repeat the earlier information regarding Site location, access, and logs to be obtained.

5.5 Procedures

The following procedures will be used during borehole geophysical logging:

- The field staff will inform the logging engineer of the desired vertical and horizontal scales. Scales should remain consistent for each logged borehole, if possible.
- Run a repeat section for each well boring.
- Repeat a minimum of 50 to 100 feet.
- Compare the repeat section to the same interval on the total log. Explain discrepancies, generally resulting from a defective tool.
- Compare the logger's total depth to the driller's total depth. Large differences may indicate conditions such as the hole sloughing, driller's measurement error, or incorrect tool depth setting.
- Do not exceed maximum recording speeds.
- Watch for depth control. Curve deflections should generally be on depth with each other.

5.6 Equipment Decontamination and Disposal

Downhole logging cables and tools will be decontaminated with fresh water or a steam cleaner as they exit the borehole. All rinse waters will be stored and properly disposed.

5.7 Documentation

The field staff will verify that the logging engineer has accurately recorded the following information appropriately on the log header:

- Correctly spelled well identifier and company name.
- Date of logging.
- Depth data, including ground level, logger's total depth, and driller's total depth.
- Logging unit number and engineer name.

- Equipment type and serial number of individual tools.
- Scale and scale changes, noted both on the heading and at the point of change on the log.
- Curve presentation, clear with no gaps or smears.
- All curves clearly labeled on the scale.

5.8 Quality Assurance

QA during geophysical logging activities will be accomplished by following this SOP. The Supervising Professional Geologist will review all geophysical logs and field notes recorded throughout the geophysical logging operations to ensure conformity with this SOP. Additionally, a repeat spontaneous potential run of a minimum of 50 to 100 feet will also provide sufficient QA during geophysical logging activities.

6. MONITOR WELL CONSTRUCTION

6.1 General Statement

The drilling and completion of each monitor well will be overseen by experienced field staff under the supervision of a California Professional Geologist (Supervising Professional Geologist) responsible for the collection of lithologic and hydrogeologic data. The field staff in consultation with the Supervising Professional Geologist will select screened intervals and determine final well depth. Monitor wells will be designed in accordance with EPA guidelines (EPA, 2002) and with applicable County of Los Angeles and State of California regulations.

Monitor wells may be installed in groups, or ‘clusters’, in order to characterize water levels and water quality in various targeted hydrogeological units at the same geographic location. The type of drilling equipment will be selected to be most appropriate for a specific target depth to be screened.

Monitor wells will be developed using a combination of conventional surging, bailing, swabbing, and pumping technologies, or using an alternative method approved by the Supervising Professional Geologist.

This SOP for monitor well construction will also apply to installation of any extraction wells or injection wells installed at the Site. Casing and screen will be selected to be most appropriate for the depth and intended use of each well.

6.2 Objectives

Data obtained from monitor wells will be used to evaluate hydrogeologic conditions, to determine water levels and direction of groundwater flow, and to characterize the chemical quality of groundwater.

The objective of monitor well construction is to provide data that are of sufficient quality to support decisions made during Work Area activities and that are representative of actual Site conditions. The relevant data obtained from monitor wells include water quality data, water levels, and hydraulic properties of the screened interval. The objectives of this task will be achieved by implementing QC procedures for construction and development, by conforming to the approach specified in this SOP, and by conforming to specific QA objectives for activities associated with drilling and installation of monitor wells. The rationale for placement of the proposed monitor wells is presented in the text of the Work Area Workplan and FSP.

6.3 Equipment and/or Instrumentation

Deep monitor wells will be drilled and constructed using mud rotary or sonic drilling methods, unless conditions warrant another method of construction. Shallower monitor wells may be drilled and constructed using hollow-stem auger drilling methods. Wells will be developed, as appropriate, using vented surge blocks, bailing, or pumping until the discharge water is clear and sand-free to the extent practicable.

Completed monitor wells may be further developed during aquifer test activities using test pumping equipment. Dedicated sampling pumps and polyvinyl chloride (PVC) sounding tubes may be installed after monitor well construction. A generator would be used to drive the pumps. Electrical connectors would be installed at each wellhead beneath the steel cover.

6.4 Preparation

A qualified driller will be selected to drill and install the wells. A qualified driller will have appropriate equipment capabilities, a California C-57 license, experience on similar sites, and documentation of health and safety training. This experience requirement shall apply both to the individual driller in the field and to the drilling company as a whole.

Prior to entering the field, authorized personnel will contact property owners and applicable agencies to obtain and comply with regulatory requirements regarding permits, access, drilling, and underground utility clearance, if required.

6.5 Procedures

Deep monitor wells will be drilled using mud rotary or sonic drilling methods unless subsurface conditions warrant another method of construction. Shallower monitor wells may be drilled and constructed using hollow-stem auger drilling methods, unless subsurface conditions warrant another method of construction. Boreholes for monitor wells will be reamed to an approximate 10-inch diameter, if necessary. A deep exploratory borehole may be converted to a monitor well by sealing the interval below the proposed screen interval with bentonite grout prior to reaming, if necessary, and well construction. Monitor wells will be installed to depths documented in the specified FSP or subsequent addendum prior to the commencement of field work. All monitor wells constructed will be attempted using a single-pass completion.

For mud rotary drilling, the on-Site field staff will closely monitor the mud density, viscosity, and sand content to assure proper hydrostatic head, thus preventing cross contamination.

For pilot injection wells, a soil sample will be collected from a target depth deemed to be representative of the saturated screened interval. The soil sample will be sieved in the field or submitted to a geotechnical laboratory to determine the approximate grain size distribution. The slot size of the screen interval for pilot injection wells will be designated in part by an evaluation of grain size distribution conducted by the field staff in consultation with the Supervising Professional Geologist. For monitor wells, the collection of the soil sample for sieve analysis is optional and will be specified in the respective Work Area FSP. The slot size of the screen intervals for monitor wells will be designated by an evaluation of lithologic log, and sieve analysis if available, conducted by the field staff in consultation with the Supervising Professional Geologist.

6.5.1 Well Construction

The following sections present options for monitor well drilling and construction. The final method will be selected by the Supervising Professional Geologist based on anticipated subsurface conditions and potential for cross contamination of hydrostratigraphic units.

6.5.1.1 Single Pass Mud Rotary or Sonic Wells

Monitor wells will be constructed using casing diameters specified in the FSP, and which may range in diameter from nominal 2- to 4- inches, with the smaller diameter casing being used for water quality/water level monitoring and larger casings used in cases where a 4-inch diameter pump is required for hydraulic testing (if PVC casing for 4-inch wells, schedule 80 does not allow use of 4-inch submersible pump due to thick wall and resultant smaller inside diameter of casing). The pilot injection wells will be constructed with nominal 6-inch diameter casing. The materials of construction for blank sections may include: schedule 40 or 80 PVC, or schedule 10 or 40 steel (mild steel, high strength low alloy and/or stainless steel). The well casing material and wall thickness will be determined by calculating grout pressure at bottom of the annular seal (factoring grout density and depth to water in casing) and comparing to resistance to hydraulic collapse pressure (factoring in heat of hydration for PVC casing), assuming that the annular seal will be placed in one continuous grouting operation. The well screen material (PVC or stainless steel) and construction method (factory slotted, louvered, or continuous wire wrap) will be specified in the FSP. In general, factory slotted screen casing is selected for monitor wells used for water quality/water level monitoring and stainless steel louvered well screens are used in monitor wells completed in aquifers that include hydraulic testing and/or pilot injection wells. The screen slot size may be pre-selected for monitor wells (0.010 or 0.020 inches) or may be designed in part based on formation sieve analysis (pilot injection wells). When using both stainless steel and mild steel casing, either extend the stainless steel casing approximately 20 feet above anticipated high water table or use a mechanical connector between the stainless and mild steel specifically designed to minimize galvanic corrosion. The evaluation of well casing and well screen construction specifications are presented in the FSP. The final verification will be conducted by the field staff in consultation with the Supervising Professional Geologist after the depth of the monitor/injection well has been determined and sieve analysis, if conducted, is available.

Monitor wells completed in mud rotary or sonic boreholes would include the use of stainless steel or PVC centralizers above and below the screened interval. For these wells, stainless steel or PVC centralizers (along PVC or stainless steel casing sections) or mild steel centralizers (along mild steel casing sections) will be placed at 40-foot intervals along blank casing. A filter pack consisting of Monterey sand no finer than Lonestar No. 0-30 for 0.010-inch well screen, or no finer than Lonestar No. 1C for 0.020-inch well screen, will be installed in the annulus between the borehole and the well screen from the total depth of the well to approximately 3 to 5 feet above the top of the screened interval. An approximate 3- to 5-foot thick bentonite seal will be emplaced in the annulus above the filter pack using bentonite pellets. Sufficient time will be allowed for the bentonite to hydrate prior to grouting the remaining annulus. The annulus between the borehole and well casing will be grouted from the top of the bentonite seal to approximately 2 to 3 feet bls using bentonite-cement (up to 5 percent bentonite) mixture, or neat cement. The cement will be tremied down the annular space of the borehole to ensure a competent surface seal. The well will be completed with a locking steel casing installed inside a steel and concrete utility vault or monument cover, depending on the monitor well location, unless regulatory requirements or Site conditions warrant alternate surface completion.

Dedicated stainless steel electric submersible pumps may be installed in monitor wells for purging and sampling groundwater. Pump intakes would be set at approximately 3 feet above the screened interval for each monitor well, unless the top of the screen interval is near or above the water table, in which case the pump would be set within the screened interval with the motor being at least 3 feet above the bottom of the screened interval.

6.5.1.2 Hollow-Stem Auger Wells

Monitor wells will be constructed using casing diameters specified in the FSP, which may range in diameter from nominal 2- to 4-inches, with the smaller diameter casing being used for water quality/water level monitoring and the larger casings used in cases where a 4-inch diameter pump is required for hydraulic testing (if PVC casing for 4-inch wells, schedule 80 does not allow use of 4-inch submersible pump due to thick wall and resultant smaller inside diameter of casing). The materials of construction for blank sections may include: schedule 40 or 80 PVC, or schedule 10 or 40 steel (mild steel, high strength low alloy and/or stainless steel). The well casing material and wall thickness will be determined by calculating grout pressure at the bottom of the annular seal (factoring grout density and depth to water in casing) and comparing to resistance to hydraulic collapse pressure (factoring in heat of hydration for PVC casing) assuming that the annular seal will be placed in one continuous grouting operation. The well screen material (PVC or stainless steel) and construction method (factory slotted, louvered, or continuous wire wrap) will be specified in the FSP. In general, factory slotted screen casing is selected for monitor wells used for water quality/water level monitoring and continuous wrap/louvered well screens are used in monitor wells completed in aquifers that include hydraulic testing. The screen slot size may be pre-selected for monitor wells (0.010 or 0.020 inches) or may be designed in part based on formation sieve analysis, if available. When using both stainless steel and mild steel casing, either extend the stainless steel casing approximately 20 feet above anticipated high water table or use a mechanical connector between the stainless and mild steel specifically designed to minimize galvanic corrosion. The evaluation of well casing and well screen construction specifications are presented in the FSP. The final verification will be conducted by the field staff in consultation with the Supervising Professional Geologist after the depth of the monitor well has been determined and sieve analysis, if conducted, is available.

A filter pack consisting of Monterey sand no finer than Lonestar No. 1C for 0.010-inch well screen, or no finer than Lonestar No. 1C for 0.020-inch well screen, will be installed in the annulus between the borehole and the well screen from the total depth of the well to approximately 3 to 5 feet above the top of the screened interval. An approximate 3- to 5-foot thick bentonite seal will be emplaced in the annulus above the filter pack using bentonite pellets. Sufficient time will be allowed for the bentonite to hydrate prior to grouting the remaining annulus. A very fine-grained (Lonestar No. 60) sand grout filter may be emplaced in the annulus above the top of the filter pack or bentonite seal. The annulus between the borehole and well casing will be grouted from the top of the bentonite seal to approximately 2 to 3 feet bls using bentonite-cement (up to 5 percent) mixture, or neat cement. The cement will be tremied down the annular space of the borehole to ensure a competent surface seal. The well will be completed with a locking cap installed inside a traffic-rated subsurface utility vault or monument cover, depending on the monitor well location, unless regulatory requirements or Site conditions warrant alternate surface completion.

Dedicated stainless steel electric submersible pumps may be installed in monitor wells for purging and sampling groundwater. Pump intakes would be set at approximately 3 feet above the screened interval for each monitor well, unless the top of the screened interval is near or above the water table, in which case the pump would be set within the screened interval with the motor being at least 3 feet above the bottom of the screened interval.

6.5.2 Monitor Well Development

Monitor wells will be developed using a combination of conventional surging, bailing, swabbing, and pumping technologies, or using an alternative method approved by the Supervising Professional Geologist.

6.5.2.1 Well Development Equipment

Wells will be developed, as appropriate, using vented surge blocks, bailers, or nondedicated pumps. Equipment used during well development includes discharge and water level measuring devices. A calibrated 5- to 55-gallon container and stopwatch or an in-line flow meter will be used to estimate discharge rates. Water levels will be measured with a water level sounder. Field equipment includes a turbidity meter to measure turbidity, and an Imhoff cone to measure sand content. Water quality parameters will also be measured using appropriate instruments during development pumping (Section 10.0).

6.5.2.2 Development Procedures

For mud rotary procedures, initial monitor well development will be conducted during the emplacement of the filter pack to ensure that the filter pack has settled. Initial development will consist of bailing the monitor well for a period of at least 1 hour, and until successive soundings of the filter pack have indicated that the filter pack has settled. Initial monitor well development may also include gently surging and swabbing the well. During initial monitor well development, the filter pack will be sounded and additional filter pack sand will be added, as required. For monitor wells constructed using sonic or hollow stem auger procedures, limited initial development would be conducted if there is evidence of bridging in the filter pack.

Final development of monitor wells will occur within approximately 2 weeks, but no sooner than 72 hours of well completion. Monitor wells will first be bailed to remove drilling mud and sand. Monitor wells will then be surged using a vented surge block, and pumped until the discharge is clear and sand-free to the extent practicable. Water quality parameters including temperature, pH, and electrical conductivity (EC) will be monitored in accordance with SOPs (Section 10.0). Development procedures may be modified due to conditions encountered at the Site.

The total volume of water purged, water quality parameters measured, sand content, water levels, and the development methods used will be recorded in the field notebook.

During routine groundwater sampling activities, the total depth of each monitor well may be measured to evaluate whether the well requires redevelopment. In the event that sediment buildup in the well casing obstructs approximately 20 percent or more of the well screen, redevelopment of the well will be conducted in accordance with this SOP. If practicable, redevelopment will be scheduled to occur before the next scheduled sampling of that well.

6.6 Equipment Decontamination and Disposal

All downhole drilling equipment will be steam cleaned prior to commencing drilling operations, and between monitor well locations. All circulation equipment will be flushed with clear water to rinse away residual drilling fluids between well locations. All rinse waters will be stored and will be properly disposed.

All materials generated from drilling activities will be contained, labeled, and stored in 55-gallon drums, roll-off bins, or Baker-type portable tanks. This includes all drilling fluids and cuttings, wash and rinse water, development water, and soil cuttings.

6.7 Documentation

A log of conditions encountered during monitor well drilling, construction, and development will be maintained in the field notebook. The field notebook will be the responsibility of the field team leader. A completion report will be compiled for each monitor well. The completion report will include the following:

- Well completion and development report for monitor wells and lithologic log form (Tables SOP-1 and SOP-3).
- Schematic well construction diagram illustrating as-built well construction details (Figure SOP-2).
- Field notes compiled by the field staff during drilling operations.
- Photographs, if available.

6.8 Quality Assurance

QA during monitor well construction activities will be accomplished by following this SOP. In addition, the Supervising Professional Geologist will review field notes, well completion and development forms, and lithologic logs throughout drilling operations to ensure conformity with this SOP.

7. WELL SURVEYS

Upon completion of well installation activities, the location, top of casing elevations, and the adjacent land surface of new monitoring wells will be surveyed by a State of California Licensed Land Surveyor.

7.1 Equipment and/or Instrumentation

The following list of equipment may be used during surveys. Site-specific conditions existing at the time the survey is performed may warrant addition or deletion of items from this list.

- Survey grade equipment with base station units (Trimble 5700 Global Positioning System receivers or equivalent).

- Personal protective equipment, traffic cones, and safety vests, as needed.

- Hand tools, field log book and marking equipment, as needed.

7.2 Procedures

The survey will be conducted by a State of California Licensed Land Surveyor. The survey equipment will be tested prior to going in the field to ensure that it works properly and meets the accuracy requirements of the project.

For each monitoring well, the Land Surveyor will determine a horizontal and vertical position at the top of casing and a vertical position at the land surface adjacent to the well. Generally, the north side of the casing will be used as the reference point unless the casing already has a reference point marked or notched on the casing.

Consistent with requirements for the state of California, latitude and longitude will be determined with Third Order methods using a minimum of 2 reference points: California Spatial Reference System Horizontal (CSRS-H) or 2 horizontal geodetic control points derived from the CSRS-H. Monitoring well locations will be tied into NAD83 UTM Zone 11 datum horizontally and NAVD88 datum vertically. All survey data will be referenced to a known reference point.

To meet California requirements, the horizontal position accuracy will be $\leq$ 100 centimeters. The vertical accuracy for relative elevations of locations in the Work Area will be < 0.01 foot. The vertical accuracy of the absolute elevation (tied to the vertical datum) may be greater than 0.1 foot. The top of casing elevations and the adjacent land surface for the wells will be surveyed relative to mean sea level and subsequent measurements of depth to water will be referenced to these data.

7.3 Documentation

The Land Surveyor will provide a written record of the horizontal location, vertical top of casing elevations, and the vertical position of the adjacent land surface of the monitoring wells. Latitude and longitude measurements will be converted to northings and eastings and reported to seven decimal places.

7.4 Quality Assurance

QA during well surveying activities will be accomplished by adhering to industry established standards for well surveying as well as to the established accuracy requirements. The Licensed Land Surveyor will review all survey data and field notes recorded throughout the well surveying activities to verify conformity with this FSP, industry standards, and Site-specific accuracy requirements. The field personnel will review the data to confirm that it meets the project goals.

8. AQUIFER TESTING

8.1 General Statement

Aquifer tests may be conducted to evaluate the hydraulic parameters of the hydrogeologic unit in selected monitor wells. Water level drawdown, recovery, and well discharge rates will be monitored throughout the test. The water quality parameters temperature, EC, dissolved oxygen (DO), oxidation-reduction potential (ORP), and pH of discharged water may also be monitored periodically. Water quality parameter data may also be used in additional investigations.

8.2 Objectives

Aquifer tests may be conducted in selected monitor wells to estimate hydraulic properties. Aquifer tests may also be used to provide data for groundwater fate and transport analysis as part of a risk/impact assessment, and to provide data to support remedial design. The decision to conduct an aquifer test at a selected monitor well will be based on the location and screened interval of the well, the need for additional data on hydraulic characteristics, and water quality data. Aquifer testing will consist of constant discharge and recovery tests. The duration and type of tests will depend on the well design and capacity, aquifer characteristics, and the observed responses in available observation wells. It is anticipated that constant discharge tests will be conducted for a pumping duration of 2 to 6 hours as specified in the FSP. Water level drawdown and recovery data will be obtained in the pumping well and any observation wells that are within the radius of influence of the pumping well during aquifer testing. Water level recovery data will be obtained from the monitor well in which the test is performed.

The objective of the hydraulic testing task is to provide data that are of sufficient quality to support decisions made during Work Area activities and that are representative of tested hydrogeologic units at the Site. The objectives of this task will be achieved by implementing QC procedures for aquifer testing, and by conforming to the procedures provided in this SOP.

8.3 Equipment and/or Instrumentation

Equipment used during aquifer testing includes discharge and water level measuring devices. A calibrated 5- to 55-gallon container and stopwatch or an in-line flow meter will be used to measure discharge rates. Water levels will be measured with calibrated water level indicators, and synchronized watches will be used to note the time of each measurement. Pressure transducers and electronic data loggers may also be used to record water levels.

8.4 Preparation

The following procedures will be performed during preparation for the constant discharge rate aquifer tests.

- Review health and safety procedures with field personnel.
- Review appropriate permits, insurance requirements, contractual requirements, and Site access procedures, if applicable.
- Measure the total depth of the well to be tested.
- Install submersible test pump in the well at the depth determined by experienced field staff under the supervision of a California Professional Geologist (Supervising Professional Geologist). Install a check valve in the discharge pipe above the pump to prevent return flow after pump shutoff.
- Assemble all necessary forms and graph paper or set up electronic plotting using a portable computer.
- Perform a limited pumping pretest to determine appropriate valve settings, to test for leaks in the discharge system, and to ensure that discharge is directed into a suitable storage tank.
- Prior to the start of pumping, measure static water level in the pumping and observation wells, and record measurement time on the appropriate water level record sheet (Tables SOP-4 and SOP-5). If the well has been pumped for development or pump performance purposes, water levels must regain prepumping levels prior to beginning the test.
- Prior to commencement of the test, the field staff in consultation with the Supervising Professional Geologist will select time increments for water level measurements and, if required, water sample collection, and will determine which monitor wells will be used as observation wells.
- Provide a reliable portable power supply if a standard power source will not be available.
- Calibrate instruments for the measurement of pH, EC, DO, ORP, and temperature, if appropriate.
- Prepare equipment for discharge measurement. A calibrated 5- to 55-gallon container or an in-line flow meter will be used to monitor discharge from wells.
- Install a gate valve in the pump discharge line. Discharge will be controlled to maintain a constant flowrate.

- Install pressure transducers and electric data loggers and recorders in selected observation wells prior to initial testing.
- Familiarize all personnel with the aquifer test procedures.
- Synchronize all personnel's watches and chronometers, then start the pump.

8.5 Procedures

The following procedures will be used to conduct the constant rate discharge aquifer test.

- Start pump and maintain a constant discharge. The field staff in consultation with the Supervising Professional Geologist will determine when to terminate the test based on a field plot of aquifer response.
- In the pumping well and observation wells, measure water levels according to the schedule specified in the FSP (an example is provided as Table SOP-6).
- Adjust valve to maintain constant discharge. Record measurements on water level record sheets with corresponding measurement time.
- After the pump is turned off, begin water level recovery measurements according to the schedule given for aquifer test start-up. Record measurements and measurement times on the water level record sheets (Tables SOP-4 and SOP-5).
- The field staff in consultation with the Supervising Professional Geologist will determine when recovery has reached approximate pre-pumping water level.
- Retrieve and download pressure transducers.

8.6 Equipment Decontamination and Disposal

Purge water from the monitor wells generated during aquifer testing activities will be discharged to Baker-type storage tanks. Disposal of purge water practices will be consistent with the SOP for handling, storage, characterization, and disposal of IDW (Section 13.0).

8.7 Documentation

Observations made during aquifer test activities will be recorded on water level record sheets in the field notebook (Tables SOP-4 and SOP-5). The field notebook will be the responsibility of the field team leader. The water level record sheets and field plots of aquifer test data will be included with the completion report for the monitor well (Table SOP-3). Electronic data collected by pressure transducers will be downloaded onto a portable computer and processed upon returning from the field. Electronic data will be stored, and hard copy plots of transducer readings will be retained in the project file with other aquifer testing field documentation.

8.8 <u>Quality Assurance / Quality Control</u>

QA objectives for aquifer test data will be satisfied by following the procedures described in this SOP.

Upon return to the office after the field event, all aquifer test mathematical computations, field data plots, and aquifer parameter computations will be checked for correctness. The applicability of the selected analytical method to the particular data set will be assessed by the Supervising Professional Geologist.

9. INJECTION TESTING

9.1 General Statement

Injection tests may be conducted to evaluate the suitability of a specific hydrostratigraphic unit or units for injection of treated groundwater. Evaluation of hydraulic parameters of the hydrogeologic unit(s) selected for injection at a given location may be accomplished by hydraulic testing of monitor wells. However, the expected duration of injection following construction and startup of the groundwater treatment system may require more robust testing, involving the duplication of expected actual injection conditions to the extent practicable. Water level, recovery, and well injection rates will be monitored throughout the test.

9.2 Objectives

Injection tests may be conducted in selected pilot injection wells to estimate hydraulic properties, assess short- and long-term water level build up and evaluate the potential for short-term injection fouling at that location, and to provide data to assess remedial alternatives that incorporate reinjection of treated groundwater. The decision to conduct an injection test at a pilot injection well will be based on existing water quality and hydraulic testing of monitor wells in the candidate reinjection area. Injection testing will consist of one or more constant rate tests at each pilot injection well. The duration of the tests will be specified in the FSP and depend on the objective of the injection test; for water level build-up/estimation of hydraulic properties the test may be shorter than one day, while for short-term fouling evaluation, the test may extend for multiple days. Water level and recovery data will be obtained in the injected well and any observation wells that are within the radius of influence of the injected well during testing. Water level recovery data will be obtained from the pilot injection well in which the test is performed.

The objective of the injection testing task is to provide data that are of sufficient quality to support decisions to evaluate, compare, and select end use of treated groundwater within the respective candidate reinjection area at the Site. The objectives of this task will be achieved by implementing QC procedures for injection testing, and by conforming to the procedures provided in this SOP.

9.3 Equipment and/or Instrumentation

Equipment used during injection testing includes flowrate and water level measuring devices. An in-line flow meter will be used to measure injection rates. Water levels will be measured with calibrated water level indicators, and synchronized watches will be used to note the time of each measurement. Pressure transducers and electronic data loggers may also be used to record water levels.

A source of potable water will also be required before conducting an injection test. An in-line filter will be installed in the potable water line to remove any particulates of 5 microns or larger, although the filter size may be modified based on aquifer characteristics.

9.4 Preparation

Several months prior to initiating pilot injection testing, consult the Regional Water Quality Control Board, Los Angeles Region, regarding the need to obtain a General Waste Discharge Requirements (WDR) permit. If necessary, obtain the WDR permit in advance of field testing and follow requirements specified in the subject permit.

In addition to the above, the following procedures will be performed during preparation for the constant rate injection tests.

- Review health and safety procedures with field personnel.
- Review appropriate permits, insurance requirements, contractual requirements, and Site access procedures, if applicable.
- Measure the total depth of the well to be tested.
- Install PVC water pipe in the well at the depth determined by the experienced field staff under the supervision of a California Professional Geologist (Supervising Professional Geologist). The diameter of the PVC pipe will also be determined by an experienced engineer in consultation with the Supervising Professional Geologist and field staff based on the expected flowrate(s).
- Assemble all necessary forms and graph paper or set up electronic plotting using a portable computer.
- Prior to commencement of the test, the field staff in consultation with the Supervising Professional Geologist will select time increments for water level measurements, and will determine which monitor wells will be used as observation wells.

- Prior to the start of injection, measure static water level in the injected and observation wells, and record measurement time on the appropriate water level record sheet (Tables SOP-4 and SOP-5). If the well has been pumped for development, pump performance or aquifer testing purposes, water levels must regain prepumping levels prior to beginning the test.
- Provide a reliable potable water supply, filtration, and conveyance piping to the injected well.
- Prepare equipment for flowrate measurement. An in-line flow meter will be used to monitor flowrates.
- Install a gate valve in the water supply line, if not already in place. Flow will be controlled to maintain a constant injection rate.
- Install pressure transducers and electric data loggers and recorders in selected observation wells prior to testing.
- Familiarize all personnel with the injection test procedures.
- Synchronize all personnel's watches and chronometers, then open water supply valves.

9.5 Procedures

In addition to the requirements specified in the WDR permit, if applicable, the following procedures will be used to conduct the constant rate injection test.

- Open valves and maintain a constant flowrate. The field staff in consultation with the Supervising Professional Geologist will determine when to terminate the test based on a field plot of water level build up in the pilot injection well and nearby observation wells.
- In the injected well and observation wells, measure water levels according to the schedule outlined in the FSP (an example is provided as Table SOP-6).
- Adjust valve to maintain constant flow. Record measurements on water level record sheets with corresponding measurement time.
- Monitor pressure drop across filters and replace as needed to maintain constant rate of flow during injection test.
- After the supply valve is closed, begin water level recovery measurements according to the schedule given for injection test startup. Record measurements

and measurement times on the water level record sheets (Tables SOP-4 and SOP-5).

- The field staff in consultation with the Supervising Professional Geologist will determine when recovery has reached the approximate pre-injection water level.

- Retrieve and download pressure transducers (Section 9.5).

9.6 Documentation

Observations made during injection test activities will be recorded on water level record sheets in the field notebook (Tables SOP-4 and SOP-5). The field notebook will be the responsibility of the field team leader. Electronic data collected by pressure transducers will be downloaded onto a portable computer and processed upon returning from the field. Electronic data will be stored, and hard copy plots of transducer readings will be retained in the project file with other injection testing field documentation.

9.7 Quality Assurance / Quality Control

QA objectives for injection test data will be satisfied by following the procedures described in this SOP.

Upon return to the office after the field event, all injection test mathematical computations, field data plots, and aquifer parameter computations will be checked for correctness. The applicability of the selected analytical method to the particular data set will be assessed by the Supervising Professional Geologist.

10. WATER LEVEL MEASUREMENT

10.1 General Statement

Water levels will be measured in monitor wells or pilot injection wells manually using a QED®, Solinst® or comparable electric water level sounder. Pressure transducers and data loggers may also be installed and used in monitor wells to monitor and record water levels over an extended period. Water levels may be measured as part of groundwater sample collection, water level monitoring, or aquifer or injection testing.

10.2 Objectives

Water levels will be measured in monitor wells, and may be measured in other types of wells installed at the Site. Resulting depth-to-water data will be recorded and may be used in conjunction with surveyed measuring point elevation data to construct water level contour maps for the hydrogeologic units of interest (Table SOP-7), and also may be used to analyze hydraulic properties collected during aquifer testing. The water level contour maps are used to interpret groundwater flow conditions and to determine horizontal and vertical gradients in monitor wells in the vicinity of the Site. The water level contour maps may also be used to aid in evaluating the distribution and movement of chemicals of concern (COCs) in groundwater and/or to support remedial design. Water level hydrographs may also be prepared to present changes in water level over time.

The objective of water level measurement is to provide data that are of sufficient quality to support decisions made during Work Area activities and that are representative of actual Site conditions. The objectives of this task will be achieved by implementing QC procedures for water level measurement, by conforming to the approach specified in this SOP, and by conforming to specific QA objectives for water level measurement.

10.3 Equipment and/or Instrumentation

The QED® or Solinst® flat tape sounder is equipped with a plastic, laminated, two-wire cable with a weighted electrode attached to the end of the cable. The cable is graduated in markings every 0.01 foot. Alternate water level sounders can be used if they provide similar accuracy and precision as QED® or Solinst® flat tape sounders. The pressure transducer consists of a downhole probe constructed of stainless steel. Some transducers have a downhole communication cable and others are self-contained and hung from a stainless steel cable to secure the probe to the wellhead.

10.4 Preparation

Water level indicators, including QED® or Solinst® flat tape sounders, will be calibrated periodically by comparing a water level measured with the indicator against a water level measured with a steel tape or other water level indicator, and by checking the distances between the water level indicator markings with a steel tape (Table SOP-7).

The following procedures will be performed in preparation for monitoring water levels with sounders:

- Identify the wells to be measured.
- Identify the established measuring point for each well. The measuring point elevation will be determined by a licensed land surveyor. To the extent practical, each monitor well should use the same measuring point (e.g., north side of casing, top of sounding tube, etc.) for water level measurements.
- Review any previous water level measurements for each well.
- Decontaminate the water level indicator by using a nonphosphate detergent wash, followed by two tap water rinses and a distilled water rinse.

The following procedures will be performed in preparation for monitoring water levels with pressure transducers:

- Review health and safety procedures with field personnel.
- Review insurance requirements, contractual requirements, and Site access procedures, if applicable.
- Identify the wells to be equipped with pressure transducers. Identify required depth setting of transducer based on the expected range of water levels over the period during which the transducer will be installed in the well and the pressure range of the respective transducer.
- Identify the type, appropriate pressure range, and model of pressure transducer to be equipped in monitor wells and review the manufacturer's installation, set-up, and maintenance requirements.
- Identify and establish the measuring point for each well. The measuring point elevation will be determined by a licensed land surveyor.
- Identify and establish a pressure reading reference point for each well. Typically, the reference point is the depth to water at the time of pressure transducer installation.

- Determine time interval of measurement (e.g., on the hour, on the quarter hour, etc.) and frequency of pressure readings. The time of measurement and frequency of pressure readings for wells equipped with pressure transducers should be equivalent across the Site.

10.5 Procedures

The following procedures will be used for measuring water levels with sounders:

- Measure the depth to water from the measuring point elevation twice for each well. The variation between the two consecutive measurements must be no more than 0.02 foot.
- For the QED® or Solinst® flat tape sounder, identify the water level and read the measurement from the marking on the flat tape.
- During periodic monitoring events, record the depth to water, date, and time of measurement on the static water level data sheet (Table SOP-7). During periodic monitoring events, examine previously measured water levels for the well. If the difference between the current water level measurement and the previous water level measurement is greater than approximately 1.0 foot, recheck the current measurement. The experienced field staff will indicate the method(s) of water level measurement and any rechecked water levels on the water level measurement form.
- Remove water level measurement equipment and decontaminate according to procedures outlined above.

The following procedures will be used when downloading pressure readings from monitor wells equipped with pressure transducers:

- Download and save pressure readings from the transducer onto a portable computer.
- Review the recorded readings and check for consistency between readings.
- Synchronize the computer time with the transducer time.
- Check the available storage of the pressure transducer and the battery life. At least 50 percent of storage capacity should be available and 75 percent of the remaining battery life should remain.
- Manually measure the depth to water in the well using procedures described above. Record the manual depth-to-water measurement as described above. If the difference between the transducer reading and the manual reading is

greater than 0.05 foot, verify the manual measurement and re-set the reference point to the current verified measured depth to water.

- Upon return to the office, downloaded pressure transducer data must be copied onto a stationary computer. Corrections for potential transducer drift, based on manual water level measurements, are then applied to the data set.

10.6 Equipment Decontamination and Waste Disposal

Water level indicators and previously used pressure transducers and cable will be decontaminated by using a nonphosphate detergent wash, followed by two tap water rinses and a final, distilled water rinse. New pressure transducers and cable will require only a distilled water rinse.

10.7 Documentation

During monitoring events, water level measurements will be recorded on a static water level data sheet in the field notebook (Table SOP-7). The field notebook will be the responsibility of the field team leader. The reported data will include depth to water in feet below the measuring point, a description of the measuring point, the date and time of the measurement, the calculated water level elevation, the method of measurement, and the initials of field personnel. Water level measurements will be reported to the nearest 0.01 foot.

All manually measured depth-to-water levels obtained from wells equipped with pressure transducers will be recorded on the static water level data sheet. The comments section of the static water level data sheet will contain information regarding the downloading of the pressure transducers.

Calibration of the manual water level indicators will be documented on a separate form (Table SOP-8).

10.8 Quality Assurance

QA of manual water level measurement data will be accomplished by following the procedures described in this SOP. Calibration information will be entered onto a calibration form. In addition, the following QA procedures for water level measurements will be implemented:

- Measure water levels with a calibrated water level indicator. Prior to measuring water levels, verify that the instruments are properly calibrated.

- At each location and/or time interval, measure water levels a minimum of two times during routine water level measurement activities. Measure water levels until two consecutive measurements are obtained that have a difference of less than 0.02 foot. Record the measurement on the static water level data sheet (Table SOP-7). Measure and record water levels to the nearest 0.01 foot.

- Compare measurement data to previous measurements obtained at the well. For variations from previous measurements greater than 1.0 foot or for data that cannot be explained by trends, repeat the measurements. If possible, use an alternative instrument to verify the accuracy of the data. Indicate the method(s) of water level measurement, the water level indicator or steel tape verification, and any rechecked water levels in the comments section on the static water level data sheet (Table SOP-7).

11. WATER QUALITY PARAMETER MEASUREMENTS

11.1 General Statement

Prior to collecting groundwater samples for laboratory analysis, the water quality parameters EC, pH, and temperature will be measured in water samples at each sampling location using a conductivity meter, a pH meter, and a field thermometer, respectively. In addition, DO, ORP, and turbidity will be measured prior to sampling using a DO meter or colorimetric kit, an ORP tester, and a turbidity meter, respectively, and will be required to determine parameter stabilization. Instruments that combine some or all of these parameter measurements may also be used.

11.2 Objectives

Water quality parameters will be measured to evaluate general water chemistry of the water sample. Stabilization of the parameters EC, pH, DO, ORP, turbidity, and temperature will be indicative of representative water from the aquifer. The following stabilization criteria are to be used when purging monitor wells:

Parameter	Stabilization Criteria
Temperature	± 3% of reading (minimum of ± 0.2 degree Celsius)
pH	± 0.1
EC	± 3%
ORP	± 10 millivolts
DO	± 0.3 milligram per liter

(±) = Plus or minus

11.3 Equipment and/or Instrumentation

Water samples will be directed through a flow-through chamber or, if necessary, placed in a transfer bottle for measurement. Field equipment consists of a conductivity meter to measure EC, a pH meter to measure pH, a field thermometer to measure temperature, a DO meter to measure DO, an ORP tester to measure ORP, and a turbidity meter to measure turbidity. Some of these measurements are available as functions of an integrated instrument or “multi-meter”.

11.4 Preparation

The probes on the conductivity meter, pH meter, DO meter, and ORP tester will be thoroughly rinsed with distilled water prior to each use. The pH meter will be calibrated in pH 4 and pH 10 buffered solutions prior to commencing field work each day. These pH values are expected to bracket the range of pH in groundwater samples collected from monitor wells at the Site. The conductivity meter will be calibrated prior to commencing field work each day. The conductivity meter will be calibrated using standard calibration solutions selected to bracket the range of conductivity expected in water samples collected at the Site. The manufacturers' instructions for use of the instruments will be followed. The field thermometer will be rinsed with distilled water prior to each use. The accuracy of the field thermometer will be determined by checking the measured reading against other thermometers, if available. A calibration check of the DO meter will be performed by rinsing the probe in distilled water and taking an instrument reading in ambient air; the value should approach 10 milligrams per liter when corrected for temperature and pressure.

11.5 Procedures

A water sample will be directed through a flow-through chamber, placed in a transfer bottle, or parameters will be measured directly at the well discharge point. The parameters EC, pH, temperature, DO, ORP, and turbidity at each sampling location will be measured as follows:

- Calibrate the pH and conductivity meters to standard solutions.
- Rinse the transfer bottle, if used, with sample water prior to filling. Fill the transfer bottle with sample water.
- Immediately submerge the probes and thermometer in the transfer bottle and record measurements after they have stabilized. Continuous readings are possible if a flow-through chamber is used.

- Record all field measurements in the field notebook.
- Compare the present measurements to measurements taken during the previous sampling round, if available. If a discrepancy exists greater than can be expected for routine changes in groundwater quality, repeat the process.
- After parameters are measured, rinse the transfer bottle, thermometer, and probes with distilled water if a transfer bottle is used.
- Discard the water sample in the transfer bottle. This water will not be used to fill sample containers.
- Record parameters at least twice for each casing volume. Indicator parameter stabilization will be defined as 3 consecutive readings that meet the stabilization criteria provided in Section 10.2 (California Environmental Protection Agency, Department of Toxic Substances Control [DTSC], 2008; EPA, 2002).

11.6 Equipment Decontamination and Waste Disposal

The transfer bottle, flow-through cell, and the probes used for measurement of field parameters will be decontaminated before and after each measurement by rinsing with distilled water. Rinsate will be collected and handled with purge water.

11.7 Documentation

Periodic measurements of EC, pH, temperature, DO, ORP, and turbidity for pumped wells will be recorded on the appropriate groundwater sampling information form (Table SOP-9). Calibration of the EC, DO, and pH meters will be documented on separate forms (Tables SOP-10 through SOP-12).

11.8 Quality Assurance

QA of water quality parameter measurements will be accomplished by following the procedures described in this SOP and by following the equipment manufacturers' operating instructions. Temperature, pH, EC, DO, ORP, and turbidity will be measured during each groundwater sampling event. Prior to measuring water quality parameters, field personnel will verify that the instruments are properly calibrated according to procedures specified by the manufacturer. Calibration documentation for each instrument will be maintained for reference purposes (Tables SOP-10 through SOP-12). Reference solutions for pH and EC will be prepared and used to properly calibrate the instrument.

The calibration of the DO meter, pH meter, and EC meter will be checked at the start of each day.

12. GROUNDWATER SAMPLE COLLECTION

12.1 General Statement

Representative groundwater samples will be collected for chemical analysis. Water quality parameters will also be measured to ensure that they have stabilized prior to collecting samples (Section 10.0). Results of water quality analysis will be used to determine the chemical characteristics of the groundwater. Groundwater samples will be analyzed for the Main COCs, specifically volatile organic compounds (VOCs) using EPA Method 8260B; 1,4-dioxane using EPA Method 522; and hexavalent chromium using EPA Method 218.6. In accordance with the specific sampling schedule, groundwater samples may also be analyzed for other constituents (Refer to respective FSP).

Representative groundwater samples for laboratory analysis will be collected from monitor wells using the low-flow / minimal drawdown method, unless the physical conditions encountered at a well necessitate another method of groundwater sampling. The following major elements of the low-flow method are discussed in more detail in subsequent sections:

- Installation of the pump intake within the screened interval to ensure sampling of formation water within the contaminant zone;
- Purging at a sufficiently low flowrate, generally between approximately 100 to 500 milliliters per minute (ml/min), to minimize turbulence and ensure minimal drawdown, generally less than about 0.33 foot, in the well during purging and sampling with the goal of sustaining a sufficiently low flowrate to avoid causing continuous drawdown in the well;
- Frequent periodic or continuous monitoring of water level drawdown in the well during purging to minimize turbulence and any potential mixing with the overlying stagnant water column; ensure minimal drawdown; and reduce disturbance and stress to the water column in the well and the water-bearing zone being sampled;
- Frequent periodic or continuous monitoring of the field indicator parameters pH, temperature, EC, DO, ORP and turbidity to verify and document stabilization of these indicator parameters prior to collection of groundwater samples; and
- Collection of groundwater samples at a discharge rate that is the same or less than the purge rate.

The low-flow method will be conducted in general accordance with guidelines, methods, and procedures that include those provided by DTSC and EPA (DTSC, 2008; EPA, 2002) (collectively the Guidance).

Other relevant logistical considerations include the manufacturer's specifications and operating instructions for the type of pump; pump and flow controller; water level indicator; and field parameter equipment used for purging and sampling.

12.2 Objectives

The objectives of the groundwater sample collection task are to provide data that are of sufficient quality to support decisions made during Work Area activities and that are representative of actual Site conditions. These data will be used to meet the data quality objectives referenced in the respective FSP/work plan, which may include one or more of the following:

- Characterize the baseline water quality conditions for the respective monitor wells.
- Characterize the general chemical water type for groundwater samples collected from the respective monitor wells.
- Monitor the areal occurrence and vertical distribution of compounds in groundwater at the Site.
- Track concentrations of Main COCs over time.
- Confirm anomalous analytical results from previous sampling events.
- Provide data to identify the target zones for groundwater extraction wellfields;
- Provide data for design of groundwater treatment system factoring in the end use(s) of treated groundwater.
- Provide data for design and permitting of treated groundwater end use.

The objective of this task will be achieved by implementing QC procedures for groundwater sample collection and by conforming to the procedures provided in this section. The Data Quality Objective with respect to the low-flow method will be achieved by purging each well in a manner that minimizes stress or disturbance to the groundwater flow system in order to collect groundwater samples that are representative of the water-bearing zone being sampled. This is achieved by pumping the well at a rate that minimizes turbulence and drawdown.

The objectives of field measurement data have been specified for accuracy and completeness parameters (refer to respective FSP). These objectives will be achieved by conforming to this section and by implementing field measurement QC procedures.

Objectives for laboratory analysis will be achieved in the laboratory by applying control limits for QC samples, including matrix spike samples, matrix spike duplicate samples, laboratory duplicate samples, internal standards, surrogates, and laboratory control standards. Laboratory data quality will be assessed for precision, accuracy, representativeness, completeness, and comparability. Project-specific reporting detection limits will be, to the extent practicable, below the established State or Federal Primary or Secondary Maximum Contaminant Levels / Notification Levels for drinking water where applicable, or at or below State Water Resources Control Board Division of Drinking Water Detection Limits for purposes of Reporting (refer to respective FSP and Quality Assurance Project Plan [QAPP]). QC limits will be established after a laboratory has been selected. These limits will be either at or below those QC limits specified in the respective analytical method. The laboratory will be California State Certified for the respective analysis. Data assessment procedures will be used to determine the achievement of objectives for chemical analyses (refer to QAPP).

12.3 Equipment and/or Instrumentation

Sample containers required for collection of water samples for chemical analysis have been specified (refer to respective FSP and/or QAPP).

A number of potentially suitable equipment and instrumentation options are available for purging and sampling using the low-flow method. Common elements of these options include:

- A water level measuring device capable of measuring water levels to the nearest 0.01 foot and monitoring drawdown periodically or continuously during purging;
- A purging and sampling pump and associated driver/controller mechanism capable of sustaining a pumping rate of about 100 ml/min without aerating the sample;
- Sufficient chemically compatible dedicated sample tubing, optimized to the degree practical to minimize total sample system volume by limiting both the total length and inside diameter of the tubing; and

- A flow-through cell and associated field parameter measurement devices for measurement and frequent periodic or continuous monitoring and recording of the field indicator parameters temperature, pH, EC, turbidity, ORP, and DO.

Other basic equipment common to all purging and sampling methods include necessary health and safety equipment; a stop watch and calibrated volumetric container for measuring and monitoring purge rate; a flow meter; a purge water container for temporary storage/staging of properly labeled and secured purge water; properly preserved sample containers; shipping containers; field data documentation forms, including labels and chain-of-custody (Tables SOP-1 through SOP-14); and decontamination supplies.

If the low-flow method cannot be used, a dedicated electric submersible pump or decontaminated Grundfos Redi-Flo2 electric submersible pump with dedicated tubing will be used to purge and sample monitor wells. Alternatively, if the monitor well has at least one foot of water but less than three feet of water above the bottom of the screened interval, a bailer can be used to purge and sample the monitor well.

12.4 Preparation

Prior to commencing a sampling event, the following information will be determined and reviewed with all field personnel:

- Objective of the monitoring event
- Analytical schedule
- Water quality parameters to be measured
- Required frequency of measurement
- Laboratory selected for sample analysis
- Level of precision required
- Appropriate methodologies to accomplish objective
- QC samples required to accomplish objective

The following procedures will be used during preparation for groundwater sample collection:

- Review project objectives, sampling location, sampling procedures, preservation, special handling requirements, packaging, shipping, analytical parameters and detection limits, and sampling schedule with all personnel.

- Review health and safety procedures with field personnel.
- Follow Site access procedures, if applicable.
- Inform laboratory of expected sample shipment.
- Obtain the appropriate sample bottles from the laboratory.
- Obtain from the laboratory blank reagent-free deionized water for VOC analyses. When using nondedicated equipment in a well to be sampled, one equipment rinsate blank sample will be collected each day, at a minimum, for VOC analysis. The purpose of the equipment rinsate blanks is to identify potential cross contamination associated with inadequate decontamination of nondedicated equipment.
- Obtain from the laboratory trip blank water vials containing reagent-free deionized water for VOC analyses at a rate of two vials for each ice chest containing samples for VOC analysis. Trip blanks will be prepared by the laboratory using reagent-free deionized water. The purpose of the trip blanks is to identify potential contamination associated with container preparation and sample transport.
- Assemble all necessary equipment and supplies that will be required to complete the sampling event. Pumps, drivers, and controllers will be inspected and pre-tested, as needed, prior to entering the field to ensure that they are in good repair and fully functional. Field personnel will compile, review, and document the manufacturer's specifications for all parameter measurement equipment, including device-specific calibration methods, measurement-reading equilibration time, and maintenance requirements, to ensure that the field parameter equipment is fully functional, meets performance specifications, is properly calibrated, and can be properly maintained.
- Determine the minimum volume of water to be removed prior to sampling.

12.5 Procedures

The following procedures will be used for the collection of groundwater samples. If possible, the low-flow / minimal drawdown method will be used during the Work Area activities.

12.5.1 Low-Flow / Minimal Drawdown Method

Because low-flow purge and sample methods draw groundwater from immediately adjacent to the pump intake, this method represents a depth-discrete sample rather than a composite sample of the entire saturated screen interval, which would be obtained by using the multiple casing volume method. Thus the pump set depth is an important consideration when using this method.

12.5.1.1 Pump Installation

Pump installation will either occur prior to the first sampling event if dedicated systems are used or prior to each sampling event if non-dedicated systems are used. In either case, the initial pump installation will include testing the pump system to evaluate and record optimal purge rates and driver/controller settings based on each well's performance as determined based on measurements of drawdown and other field parameters, including turbidity, if available.

Prior to setting pumps in each well, all pumps and associated equipment will be thoroughly decontaminated in accordance with applicable SOPs and specific manufacturer's recommendations.

Pump-set depths will be determined in advance based on well construction specifications and hydrogeologic conditions at each well. The pump intake will generally be set at the middle of the saturated screened interval. Special consideration will be given to water table wells that exhibit a wide range of seasonal variation, in which case the pump intake may be set at a depth equivalent to the middle of the saturated screened interval during lower water level elevation conditions.

For a given well, the pump intake will be set at the same depth throughout the course of the monitoring program.

Pump systems will be installed with care by slowly and gently lowering the equipment to, but not beyond, the pre-determined pump set depth to minimize turbulence and disruption of the static water column above the pump intake, and to minimize disturbance of bottom sediments and the groundwater in the well adjacent to and below the pump intake.

After each initial pump installation, the pump system will be activated, and drawdown will be measured and recorded as the flowrate is adjusted to optimize non-turbulent flow and achieve minimal drawdown. The well-specific driver/controller settings corresponding to the optimal flowrate for achieving minimal turbulence and drawdown will be recorded for each well for use and further refinement during each subsequent purging and sampling event.

12.5.1.2 Purging

For each well to be sampled, field personnel will calculate and record the depth of the pump intake; the inner diameter and total length of the discharge tubing; and the total system volume for each system installation, which includes the sum of the volume of the pump, the volume of the discharge tubing, and the volume of the flow-through cell used to measure indicator parameters, compensated for the displacement volume of the parameter probes.

System volume will be recorded in the same units that discharge volume will be recorded during purging and sampling, generally milliliters or liters. To the extent practical, thick-walled discharge tubing will be used to minimize tubing/purge volumes. In no case will the purge volume at the time of sampling be less than twice the total system volume.

The overall goal when purging each well is to stabilize the flowrate as soon as possible to achieve the least amount of stress/turbulence and stabilize drawdown for purging and sampling, with a target drawdown on the order of about 0.1 meter (0.33 foot) or less. Purging will commence at the lowest flowrate possible to achieve and sustain continuous discharge at the surface, while simultaneously monitoring the water level to adjust flowrate downward to minimize drawdown. Measurements of discharge rate will be made using in-line flow meters and/or stop watches and graduated cylinders, beakers, or other calibrated small-volume containers sufficient for quantifying target flowrates that are typically on the order of about 100 ml/min to 500 ml/min. Drawdown will be calculated as the difference between the pumping water level and the pre-pumping static water level.

The actual flowrate and the minimal drawdown goal may be difficult to achieve under some circumstances due to hydraulic properties of the geologic formation within the screened interval. Adjustments may be required based on Site- and/or well-specific conditions, equipment, and/or personal experience. If the minimal drawdown cannot be maintained, the actual drawdown and flowrate will be monitored and documented on the field data documentation forms.

In addition to drawdown and flowrate, indicator parameters will be continuously monitored during purging and sampling. Indicator parameters will be monitored using a flow-through cell of known volume and calibrated meters and probes. Frequency of monitoring for these parameters is a function of the total system volume and purge rate. Indicator parameter monitoring will commence after purging a minimum of one complete total system volume. The minimum time interval between subsequent indicator parameter readings will be equal to or greater than the time required to replace the internal volume of the flow-through cell plus the measurement/reading equilibration time, generally expected to be on the order of every 3 to 5 minutes. Indicator parameter stabilization will be defined as 3 consecutive readings after the initial system volume is removed that meet the following stabilization criteria as further detailed in the Guidance (DTSC, 2008; EPA, 2002).

INDICATOR PARAMETER	STABILIZATION CRITERIA
Drawdown	Generally <0.1 meter (<0.33 foot)
Flowrate	Generally 100 to 500 ml/min
Temperature	± 0.2 degree Celsius or ± 3% of reading
pH	± 0.1 pH units
EC	± 3% of reading (mS/cm)
DO	± 0.3 mg/l
Turbidity	1 NTU or ± 10% when turbidity is >10 NTUs
ORP	± 10mV

< = Less than; mS/cm = milliSiemens per centimeter; mg/l = milligrams per liter; NTU = nephelometric turbidity unit; > = Greater than; mV = millivolts; ± = plus or minus

Minimal flowrate, minimal drawdown, and indicator parameter stabilization will be confirmed as soon as possible after commencing purging. Documentation will be maintained in a detailed and well-organized format on the appropriate field data documentation forms (Tables SOP-1 through SOP-14).

12.5.2 Multiple Casing Volume Method

The following procedures will be used for the collection of groundwater samples using the multiple casing volume method:

- Measure depth to water in well to be sampled (Section 9.0).
- Determine the volume of water to be purged from the monitor well. One casing volume is determined by multiplying the volume of water in 1 foot of monitor well casing by the distance between the bottom of the monitor well and the water level measured in the monitor well.
- Purge the monitor well until at least three casing volumes have been removed and the field parameter measurements pH, EC, and temperature have stabilized, provided that the well yields sufficient groundwater to remove three casing volumes within approximately 90 minutes. In the event that a monitor well

yield is insufficient, one casing volume will be purged. If one casing volume cannot be purged within 90 minutes, purge the well until the water draws down to the pump intake (typically set at the top of the screen, ensuring that a volume of water equivalent to the volume standing in the blank casing of the well above the screened interval will be purged) and discontinue pumping. The well should be allowed to recover for 2 hours after purging has stopped. Then the well should be sampled as soon after 2 hours as possible. In no event should a monitor well be sampled more than 24 hours following completion of purging. Measure the water quality parameters to determine whether parameters have stabilized (Section 10.0).

- After purging is complete, collect water samples for laboratory analysis.

12.5.3 Sample Collection and Handling

- Record the following information on the field data sheet:
  - Static depth to groundwater.
  - Time that bailing or pumping is started.
  - Time of sample collection.
  - Number of containers collected and analyses to be performed.
  - Field parameter measurements for each purge volume.
  - Field parameter measurements at time of sampling.
  - Physical characteristics of the water including color, odor, turbidity, etc.
  - Total gallons removed at time of sampling.
  - Total gallons removed at end of sampling.
- Collect water samples in appropriate sample containers from the pump discharge.
- Attach labels to sample containers immediately after samples are collected.
- General sample collection statements:
  - If sample bottles for analytes specified in FSP contain preservatives or are sterile, do not rinse bottles; otherwise, triple-rinse unpreserved (not sterile) bottles prior to sample collection.
  - If samples are to be cooled, store on ice in ice chest immediately after collecting.
- Specific sample collection statements:

- Collect headspace-free water samples for VOC analysis in pre-acidified 40-milliliter (ml) glass sample vials preserved with hydrochloric acid. Do not rinse the glass vials with discharge water prior to sample collection. To avoid aeration, hold the glass vial at an angle so the stream of water flows down the side. To eliminate any air bubbles, fill the vial until it forms a meniscus and replace the Teflon-lined cap. Turn the vial upside down and tap it to check for air bubbles. If there is any headspace in samples collected for VOC analyses, discard the original vial and use a new pre-acidified vial. Repeat this procedure until a sample without headspace is obtained. Collect three 40-ml vials for each VOC analysis for each well sampled. Place samples in a resealable plastic bag and store on ice in an ice chest immediately after collection.
- If water samples are to be analyzed for constituents that require filtration and acidification (for example, for priority pollutant metals), the samples can be collected filtered in the field or filtered in the laboratory as follows:
    - Field filtered samples: Filter water samples in the field prior to collection in preacidified bottles. Collect water samples for constituents in preacidified bottles as specified in the FSP. In some cases, it may be possible to combine different constituents that require filtration and the same preservative from the same well into one bottle if the laboratory confirms adequate volume of water is available in the respective bottle (e.g., cations and priority pollutant metals). Do not rinse sample bottles with discharge water prior to sample collection. Store on ice in an ice chest immediately after collection.
    - Laboratory filtered samples: Collect water samples for constituents in unpreserved (non-acidified) bottle (same size and material as specified in FSP). Triple-rinse unpreserved sample bottles with sample water prior to sample collection. Instruct laboratory to filter and acidify immediately upon receipt. Store on ice in an ice chest immediately after collection.
- If coliform bacteria analysis is conducted, wear gloves when collecting samples. Do not rinse the bottles. The bottles are sterile, so care must be taken not to contaminate the bottle or cap. Once the distribution line is flushed and the flow reduced, quickly open the bottle (but do not set the cap down), hold the cap by its outside edges only, and fill the sample bottle to just above the 100 ml line leaving 1 inch of headspace. Cap the

bottle immediately and place it into a cooler with ice for delivery or overnight shipment to the laboratory.

- Collect one field duplicate sample for every 10 samples collected during the sampling event. Analyze duplicate samples for the same compounds as original samples. Send duplicate samples along with the original samples to the primary laboratory. The location for duplicate sample collection will be determined prior to each sampling round.
- Collect one field blank sample daily or for every 10 samples collected during the sampling event, whichever is more frequent. Analyze field blank samples for VOCs. The field blank will be prepared at a sampling location by the field personnel using reagent-free deionized water obtained from the primary analytical laboratory.
- If nondedicated sampling equipment is used, collect one rinsate blank sample daily or for every 10 samples collected during the sampling event, whichever is more frequent. Analyze field blank samples for organic constituents. The field blank will be prepared at a sampling location by the field personnel using reagent-free deionized water obtained from the primary analytical laboratory.
- Include one trip blank sample containing reagent-free deionized water for VOC analysis to accompany each ice chest shipped each day for these analyses. The trip blanks will be prepared by the primary analytical laboratory, using reagent-free deionized water.
- Prepare split samples for EPA or other agencies during groundwater sampling, if required, by alternately filling agency and project sample containers in sequential order for each parameter until all containers are filled.
- Handle duplicate, trip blank, and field blank water samples in a manner identical to other water samples.
- Record all pertinent data concerning each sample on the groundwater sampling information field data form (Table SOP-9).
- Record all pertinent data concerning each duplicate, split, and blank sample on the appropriate field data log forms (Tables SOP-13 and SOP-14).
- Complete chain-of-custody record at each sample location prior to sampling at the next sample location.
- Prepare chain-of-custody record (Table SOP-2) at the completion of each sampling event.

- Package, store, and transport the samples to the laboratory at the conclusion of each sampling day. Samples will be delivered to the laboratories as quickly as possible, via laboratory courier, if available.

12.6 Sample Containers, Preservation, and Transmittal

A list of the types and volumes of sample containers used for groundwater sampling has been prepared (refer to FSP). The laboratory will prepare the 40-ml glass vials and septa used to collect samples for VOC analysis. The vials will be washed with detergent, rinsed with reagent-free deionized water, and dried 1 hour at 105 degrees Celsius. Vials to be used for VOC analysis will be preserved with hydrochloric acid. These vials will not be rinsed with sample water prior to collection of samples.

Upon collection, all samples will be sealed with custody seals, labeled, and stored on ice in ice chests until received by the laboratory. Sample shipments will contain completed chain-of-custody records stored in resealable plastic bags for shipment to the laboratory (Table SOP-2). Each ice chest containing samples will be clearly labeled and sealed to prevent tampering. Standard sample control and chain-of-custody procedures will apply.

12.7 Equipment Decontamination and Disposal

Nondedicated downhole equipment will be decontaminated between monitor wells to be sampled during the Work Area activities by using a nonphosphate detergent wash, followed by a potable water rinse and a final, distilled water rinse.

Water generated during decontamination procedures will be containerized and stored onsite. Spent health and safety equipment will be containerized and stored onsite.

Purge water from monitor wells will be contained at the wellhead and transported to an on-Site storage tank or other designated purge water storage container. Disposal of purge water practices will be consistent with the SOP for handling, storage, characterization, and disposal of IDW (Section 13.0).

12.8 Documentation

A record of sample identification numbers will be maintained on standardized field data forms (Tables SOP-2, SOP-13 and SOP-14). Additional field data include a record of significant events, observations, measurements, personnel, Site conditions, sampling procedures, measurement procedures, and calibration records.

All field data entries in the field notebook will be signed, dated, and kept as a permanent record. The field notebook will be the responsibility of the field team leader. Erroneous entries will be corrected by crossing a line through the error and entering the correct information. Corrections will be initialed by the person making the re-entry.

Sample identification documents will be prepared so that sample identification and chain-of-custody are maintained and sample disposition is controlled. The following sample identification documents are to be used:

- Sample identification label (Figure SOP-1)
- Chain-of-custody and analysis request forms (Table SOP-2)

Standard sample identification labels and chain-of-custody records will be used to record all information. Sample documentation forms and labels will be completed with waterproof ink. The sample documentation forms will accompany the samples to the laboratory. Copies of the sample documentation forms will be retained by the samplers and sent directly to the QA Manager designated for the project.

Preprinted adhesive sample labels will be secured to the sample containers by field personnel. The following information will be recorded on the sample label:

- Sample location/identifier
- Depth at which sample was collected, if applicable
- Date and time sample was collected
- Analyses to be performed
- Preservation instructions
- Project number
- Sampler's initials
- Any other pertinent information
- Any special instructions to laboratory personnel

Official custody of samples will be maintained and documented from the time of sample collection until the validation of analytical results. The chain-of-custody record is the document that records the transfer of sample custody. The chain-of-custody record also serves to cross reference the sample identifier assigned by the QA Manager with the sample identifier assigned by the laboratory. The chain-of-custody record includes the following information:

- Sample location/identifier
- Project number
- Sampling date
- Sampling personnel
- Shipping method
- Sample description
- Sample volume
- Number of containers
- Sample destination
- Preservatives used
- Analyses to be performed
- Special handling and reporting procedures
- The identity of personnel relinquishing and accepting custody of the samples

The sampling personnel will be responsible for the samples and will sign the chain-of-custody record to document sample transferal or transport. Samples will be packaged in sealed containers for transport and dispatched to the appropriate laboratory for analysis with a separate chain-of-custody record accompanying each shipment. The method of transport, courier name(s), and other pertinent information will be entered on the chain-of-custody record. During transport, samples will be accompanied by the chain-of-custody record.

Once received at the laboratory, laboratory custody procedures apply. It is the laboratory's responsibility to acknowledge receipt of samples and verify that the containers have not been opened or damaged. It is also the laboratory's responsibility to maintain custody and sample tracking records throughout sample preparation and analysis.

12.9 Quality Assurance

QA for groundwater samples collected during routine groundwater monitoring will be accomplished by following the procedures described in this SOP and by monitoring laboratory QA procedures. Laboratory QA procedures are specified in the laboratory's QA Manual, and evaluation of laboratory QA documentation is described in the QAPP. In addition, the following field QC methods will be implemented during sample collection:

- Collect one field duplicate sample for every 10 samples collected during the sampling event. Send duplicate samples along with original samples to the primary laboratory. The purpose of the duplicate sample is to determine the precision of field sampling and laboratory analysis techniques. Field duplicate samples will be laboratory blind duplicates. A false well identifier will be assigned for the sample identifier and recorded on the sample label and chain-of-custody record along with a false sample collection time. The actual sample location, sample time, and corresponding false sample identifier and sample time will be recorded on the duplicate sample log form (Table SOP-14).
- Collect one equipment rinsate blank sample each day or for every 10 samples collected, whichever is more frequent, if nondedicated sampling equipment is used in one or more wells. Equipment rinsate samples will be analyzed for organic constituents. If laboratory analysis of the equipment rinsate sample indicates inadequate decontamination procedures, corrective action will be taken as detailed in the QAPP. Record blank sample preparation on the appropriate field form (Table SOP-13).
- Collect one field blank sample each day during the sampling event or for every 10 samples collected, whichever is more frequent. Sampling personnel will prepare the field blanks at a predetermined sample location using reagent-free deionized water obtained from the analytical laboratory. The purpose of the field blank is to identify possible contamination associated with sample collection and transport. Record blank sample preparation on the appropriate field form (Table SOP-13).
- Include one trip blank sample containing reagent-free deionized water for VOC analyses to accompany each ice chest shipped each day for these analyses. The trip blanks will be prepared by the analytical laboratory using reagent-free deionized water. The purpose of the trip blank is to identify possible contamination associated with container preparation and sample transport.

- Prepare split samples for EPA or other agencies during groundwater sampling, if required, by alternately filling agency and primary sample containers in sequential order for each parameter until all containers are filled.
- Identify duplicates and blank samples in the same manner as all other samples. Identifiers will be determined prior to the sampling round and will be indicated in the sampling memorandum issued to field sampling personnel prior to the start of sampling activities.
- Prior to the start of each sampling round, the field staff under the supervision of a California Professional Geologist (Supervising Professional Geologist) will determine the sampling locations for field blank preparation and duplicate sample collection. Additionally, the field staff in consultation with the QA Manager will specify labeling procedures for these samples. This information will be contained in a sampling memorandum issued to field sampling personnel prior to the start of sampling activities.

13. HANDLING, STORAGE, CHARACTERIZATION, AND DISPOSAL OF INVESTIGATION-DERIVED WASTES

Wastes generated during this investigation will include water, soil, drilling fluid and disposable personal protective equipment/sampling equipment.

A central staging area for temporary storage of IDW and/or decontamination of drilling and sampling equipment will be established within the RDWA. The central staging area will have sufficient area for managing IDW in 55-gallon drums, roll-off bins and/or temporary aboveground storage tanks (collectively referred to as IDW containers). The field team leader will work with the Project Coordinator to develop and document the unique IDW container Identification Numbers (included with each IDW container), dates of IDW placement into the container, the location of the container, and the date when the container was sampled for waste characterization.

A sticker/label that reads ‘This Container On Hold Pending Analysis’ will be affixed to the outside of each IDW container once IDW is first placed in them. The sticker/label will detail the appropriate contact information. If the waste is found to be hazardous, the label will be changed to read “Hazardous Waste”.

Representative samples will be collected for waste profiling from consolidated IDW containers and sent to a California-certified laboratory for analysis in accordance with California Code of Regulations, Title 22, Section 66261.24. Following waste profiling, the IDW will be transported by a licensed waste hauler for disposal at an appropriately permitted solid or hazardous waste facility in accordance with Federal and State requirements. IDW will be stored for no more than 60 days during characterization and consolidation.

14. REFERENCES CITED

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U.S. Environmental Protection Agency (EPA), 2002. Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers, OSWER, EPA-S-02-001. Ground Water Forum Issue Paper. May 2002.

_____, 2016. Consent Decree regarding Operable Unit 2 at the Omega Chemical Corporation Superfund Site, Case 2:16-cv-02696 Document 4-1. Filed with United States District Court, Central District of California, Western Division. April 20, 2016.

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ATTACHMENT C-1 TABLES

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TABLE SOP-1
LITHOLOGIC LOG FORM

BOREHOLE ID:	LOCATION:		PAGE 1 OF
PROJECT NO.:	PROJECT NAME:	LOGGED BY:	
WEATHER:			DATE(S):
DRILLING METHOD, EQUIPMENT:			HOLE DIA.:
DRILLING CONTRACTOR:		OPERATOR:	
SAMPLING METHOD, EQUIPMENT:			
SURFACE ELEVATION: ft/msl	TOTAL DEPTH: ft/bls	DTW: ft/bmp	
REMARKS:			

SAMPLES	CORE RECOVERY	DEPTH (feet bls)	GRAPHIC LITHOLOGY	USCS GROUP SYMBOL	LITHOLOGIC DESCRIPTION Textural classification (modifier, root), Munsell color descriptor (value), moisture content, consistency or relative density, plasticity, grain size, sorting, roundness, miscellaneous properties.	NOTES, REMARKS, OBSERVATIONS
		0				

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TABLE SOP-1
LITHOLOGIC LOG FORM

BOREHOLE ID:	LOCATION:		PAGE OF
PROJECT NO.:	PROJECT NAME:	LOGGED BY:	
WEATHER:			DATE(S):

SAMPLES	CORE RECOVERY	DEPTH (feet bls)	GRAPHIC LITHOLOGY	USCS GROUP SYMBOL	LITHOLOGIC DESCRIPTION Textural classification (modifier, root), Munsell color descriptor (value), moisture content, consistency or relative density, plasticity, grain size, sorting, roundness, miscellaneous properties.	NOTES, REMARKS, OBSERVATIONS

ft/bls = Feet below land surface; ft/bmp = Feet below measuring point;
DIA = Diameter; USCS = Unified Soil Classification System
ft/msl = Feet mean sea level; DTW = Depth to water

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TABLE SOP-2

HARGIS + ASSOCIATES, INC. HYDROGEOLOGY • ENGINEERING

CHAIN-OF-CUSTODY RECORD AND ANALYSIS REQUEST FORM

DATE ________ PAGE ____ OF ____

PROJECT NAME	PROJECT No./TASK No.	SAMPLE CONTAINERS	ANALYSIS REQUESTED	ESTIMATED CONCENTRATION RANGE (ppb) FOR VOA'S	SPECIAL HANDLING	LABORATORY INFORMATION
PROJECT MANAGER	Phone No.					
QA MANAGER	Fax No.					
SAMPLER (SIGNATURE)	SAMPLER (PRINTED)					

LAB ID	SAMPLE ID	SAMPLE COLLECTION		MATRIX			PRESERVATION					SAMPLE CONTAINERS	ANALYSIS REQUESTED	ESTIMATED CONCENTRATION RANGE	SPECIAL HANDLING	REMARKS
		Date	Time	Soil	Ground-water	Surface water	HCl	HNO_3	NaOH	H_2SO_4	Ice					
Total number of Containers per analysis:															Total No. of Containers: ________	

Relinquished by:	Date	Received by:	Date
Company	Time	Company	Time
Relinquished by:	Date	Received by:	Date
Company	Time	Company	Time

INSTRUCTIONS

1. Fill out form completely except for shaded areas (lab use only); sign only after verified for completeness.
2. Complete in ballpoint pen. Draw one line through errors, initial and date correction.
3. Indicate number of sample containers in analysis request space; indicate choice with ✓ or x.
4. Note applicable preservatives, special instructions, and deviations from typical environmental samples.
5. Consult project QA documents for specific instructions.

Sample Receipt: **Temp. @ receipt ________ °C**

- ☐ **No. of containers correct**
- ☐ **received good condition/cold**
- ☐ **custody seals secure**
- ☐ **conforms to COC document**

Shipment Method: ________________

Send Results to: ________________

☐ 9171 TOWNE CENTRE DRIVE, SUITE 375 SAN DIEGO, CA 92122 (858) 455-6500

☐ 1640 SOUTH STAPLEY DRIVE, SUITE 209 MESA, AZ 85204 (480) 345-0888

☐ 7400 NORTH ORACLE ROAD, SUITE 202 TUCSON, AZ 85704 (520) 881-7300

Send invoice to San Diego, CA
Attn: Accounts Payable

ORIGINAL: LABORATORY YELLOW: QA MANAGER PINK: FIELD/TASK MANAGER

TABLE SOP-3
WELL COMPLETION AND DEVELOPMENT REPORT

Project No. ____________

Project Name ___________________________

COMPLETION REPORT FOR WELL __________

Drilling Company: ____

Driller: ____

Drill Rig: ____

Date drilling started: ____

Date drilling completed: ____

Description of drilling ____

____

____

A. GENERAL

Location: ____

Location coordinates: x ____________ y ____________

Total depth of borehole: ______________________________ feet bls

Borehole diameter: ______________ inches, from ____________ to ___________ feet bls

______________ inches, from ____________ to ___________ feet bls

Lost circulation zones: ____

Lithology logged by: ____

B. CONSTRUCTION

Conductor Casing

Type: ______________________________________ , O.D.: __________

Wall thickness: _________________ , from ______________ to ______________ feet bls

Centralizers/Shoe: ____

TABLE SOP-3
WELL COMPLETION AND DEVELOPMENT REPORT

Project No. ____________

Project Name _________________________

COMPLETION REPORT FOR WELL __________

Well Casing

Type: ____ , O.D.: _________

Wall thickness: _________________ , from ______________ to ______________ feet bls

Type: ____ , O.D.: _________

Wall thickness: _________________ , from ______________ to ______________ feet bls

Well Screen

Type: ____ , O.D.: _________

Wall thickness: _________________ , from ______________ to ______________ feet bls

Type: ____ , O.D.: _________

Wall thickness: _________________ , from ______________ to ______________ feet bls

Centralizers/Shoe: ____

C. GROUT AND CEMENTING RECORD

Annular space: ____

Type of cement/grout: ____

Method of emplacement: ____

Approximate number of yards/bag: ____

Comments: ____

____

____

Annular space: ____

Type of cement/grout: ____

Method of emplacement: ____

Approximate number of yards/bag: ____

Comments: ____

____

TABLE SOP-3
WELL COMPLETION AND DEVELOPMENT REPORT

Project No. ____________

Project Name _________________________

COMPLETION REPORT FOR WELL __________

D. **GRAVEL PACK**

Type: ______________________________ , from ___________ to ___________ feet bls

Volume emplaced: _________________ , Method emplaced: _______________________

Type: ______________________________ , from ___________ to ___________ feet bls

Volume emplaced: _________________ , Method emplaced: _______________________

Grout Filter

Type: ______________________________ , from ___________ to ___________ feet bls

Volume emplaced: _________________ , Method emplaced: _______________________

Bentonite Seal

Type: ______________________________ , from ___________ to ___________ feet bls

Volume emplaced: _________________ , Method emplaced: _______________________

E. DEVELOPMENT RECORD

Date: ____

Procedure: ____

Duration: ________ minutes

Procedure: ____

Duration: ________ minutes

Pumping duration: ________ minutes

Average pump discharge rate: _______ gpm

Drawdown at end of pumping: ________ feet bls

Field parameters (initial): pH _______________ , Conductivity _____________ (umhos),

Temperature _____ (°C), Turbidity ____

Field parameters (final): pH ________________ , Conductivity _____________ (umhos),

Temperature _____ (°C), Turbidity ____

TABLE SOP-3
WELL COMPLETION AND DEVELOPMENT REPORT

Project No. ____________

Project Name _________________________

COMPLETION REPORT FOR WELL __________

F. PUMP INSTALLATION DATA

Pump installer: ____

Installation date: _______________

Pump purpose/type: ____

Pump model/specs: ____

Pump setting: ____

Pump purpose/type: ____

Pump model/specs: ____

Pump setting: ____

Surface completion (hole vault type, etc.): ______________________________

G. REFERENCE ELEVATIONS

Land surface elevation: ____________ feet msl

Measuring point elevation: ____________ feet msl

Description of measuring point: ______________________________

Date surveyed: _____________ , by: ______________________________

H. COMMENTS AND NOTES RE DRILLING WELL CONSTRUCTION OPERATIONS

____

____

____

____

____

TABLE SOP-3
WELL COMPLETION AND DEVELOPMENT REPORT

Project No. ____________

Project Name __________________________

MONITOR WELL PLACEMENT FORM

Proposed Well ID:__________________________ Actual Well ID: ________________________

Date:____________________________________ By: __________________________________

Street Address or APN: ____

City/Town: ____

Nearest Cross Street: ____

Thomas Brothers Reference: ____

Owner/Jurisdiction: ____

County Permit No. : ____

USA Alert Ticket: ____

Comments:____

____

____

Sketch Map

TABLE SOP-3
WELL COMPLETION AND DEVELOPMENT REPORT

Project No. ____________

Project Name _________________________

DEVELOPMENT REPORT FOR WELL ______

A. DEVELOPMENT REPORT

Well Type: ____

Development Company: ____

Developer/Helper: ____

Development Rig: ____

Date of Development: ____

H+A Field Notebook: ____

H+A Personnel: ____

Description of Development: ____

____

____

____

B. WELL DEVELOPMENT

Total Well (Driller): ____ feet bls

Depth to bottom of well before development: ______________________________ feet bls

Bottom: soft, medium, hard

Depth to water before development: ____________________________________ feet bls

Procedure: ____

Duration: _________ minutes, Comment: ____

Procedure: ____

Duration: _________ minutes, Comment: ____

Procedure: ____

Duration: _________ minutes, Comment: ____

Procedure: ____

Duration: _________ minutes, Comment: ____

TABLE SOP-3
WELL COMPLETION AND DEVELOPMENT REPORT

Project No. ____________

Project Name _________________________

DEVELOPMENT REPORT FOR WELL ______

Procedure: ____

Duration: ________ minutes, Comment: ____

Pumping duration: ________ minutes

Field parameters (initial): pH _______________ , Conductivity _____________ (umhos),

Temperature _____ (°C), Turbidity ____

Average pump discharge rate: ___________ gpm Gallons purged: _________________

Depth to water at end of pumping: ______________ feet bls, Drawdown __________ feet

Specify Capacity: ____________________ gpm/ft

Field parameters (final): pH ________________ , Conductivity _____________ (umhos),

Temperature _____ (°C), Turbidity ____

Depth to bottom of well after development: _______________________________ feet bls

Bottom: soft, medium, hard

Depth to water after development and recovery: ___________________________ feet bls

Measured: ___________________ hours after final pumping

C. PUMP INSTALLATION DATA

Pump installer: ____

Installation date: ____

Pump purpose/type: ____

Pump model/specs: ____

Pump setting: ____

Pump purpose/type: ____

Pump model/specs: ____

Pump setting: ____

Comments: ____

____

TABLE SOP-3
WELL COMPLETION AND DEVELOPMENT REPORT

Project No. ____________

Project Name _________________________

DEVELOPMENT REPORT FOR WELL ______

D. SURVEY DATA

Surveyor: ____

Date surveyed: ____

Land surface elevation: _____________ feet msl

Measuring point elevation: ____________ feet msl

Location coordinate: x _________________________ y _________________________

Description of measuring point: ____

E. COMMENTS

____

____

____

____

____

____

____

____

FOOTNOTES

°C = degrees Celsius
bls = Below land surface
msl = Mean sea level
O.D. = Outer Diameter
umhos = Micromhos
ID = Identifier
H+A = Hargis + Associates, Inc.
APN = Assessor’s Parcel Number
gpm = Gallons per minute

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TABLE SOP-4
WATER LEVEL RECORD SHEET

PUMPED WELL _______________

Page ____ of ______

MEASURING POINT: __________ ft (above land surface) ELEV OF MEAS PT: __________ ft (above mean sea level)

WELL LOCATION/COORDINATES: ____

STATIC WATER LEVEL: ____________________ DATE/TIME: ______________________

DATE/TIME	TIME SINCE PUMPING STARTED (minutes)	DEPTH TO WATER (feet)	DRAWDOWN (feet)	TIME SINCE PUMPING STOPPED (minutes)	t / t '	PUMPING RATE	REMARKS (INCLUDE METHOD OF MEASUREMENT)

ft = feet; ELEV OF MEAS PT = Elevation of measuring point;
t = elapsed time since start of pumping; t' = elapsed time from end of pumping

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TABLE SOP-5
WATER LEVEL RECORD SHEET

OBSERVATION WELL _______

Page _____ of ______

RESPONSE TO PUMPING AT WELL: _______________ DISTANCE TO PUMPING WELL (feet): ______________

MEASURING POINT: __________ ft (above land surface) ELEV OF MEAS PT: __________ ft (above mean sea level)

WELL LOCATION/COORDINATES: ____

STATIC WATER LEVEL: ____________________ DATE/TIME: _______________________

DATE/TIME	TIME SINCE PUMPING STARTED (minutes)	DEPTH TO WATER (feet)	DRAWDOWN (feet)	TIME SINCE PUMPING STOPPED (minutes)	t / t '	REMARKS (INCLUDE METHOD OF MEASUREMENT)

ft = feet; ELEV OF MEAS PT = Elevation of measuring point;
t = elapsed time since start of pumping; t' = elapsed time from end of pumping

TABLE SOP-6

SCHEDULE FOR WATER LEVEL MEASUREMENTS
DURING AQUIFER AND INJECTION TESTING

AQUIFER TESTING

FREQUENCY OF WATER LEVEL MEASUREMENT	TIME PERIOD
1 every 30 seconds	First 5 minutes
1 every minute	Next 10 minutes
1 every 2 minutes	Next 20 minutes
1 every 5 minutes	Next 30 minutes
1 every 10 minutes	Next 60 minutes
1 every 20 minutes	Next 4 hours (if required)
1 every 30 minutes	Next 4 hours (if required)
1 every 60 minutes	For duration of pumping (if required)

INJECTION TESTING

FREQUENCY OF WATER LEVEL MEASUREMENT	TIME PERIOD
1 every 30 seconds	First 5 minutes
1 every minute	Next 10 minutes
1 every 2 minutes	Next 20 minutes
1 every 5 minutes	Next 30 minutes
1 every 10 minutes	Next 60 minutes
1 every 20 minutes	Next 4 hours
1 every 30 minutes	Next 4 hours
1 every 60 minutes	For duration of test

NOTES: Water levels may be measured more frequently depending on field conditions and water level response; if transducers are used, water levels will be measured on a logarithmic time basis.

The same frequency of water level measurements will be used for both the pumping/injection and recovery phases.

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TABLE SOP-7
STATIC WATER LEVEL DATA SHEET

MONTH/YEAR: ______

PROJECT NUMBER: ______

METHOD OF MEASUREMENT/SOUNDER IDENTIFIER: ______

WELL IDENTIFIER	DATE	TIME	MEASURING POINT	DEPTH TO WATER FROM REFERENCE POINT (± feet)	REFERENCE POINT ELEVATION (± feet msl)	WATER LEVEL ELEVATION (± feet msl)	PREVIOUS DEPTH TO WATER (feet)	CHANGE IN WATER LEVEL (± feet)	COMMENTS	INITIALS

Msl = Mean sea level

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TABLE SOP-8
WATER LEVEL INDICATOR
CALIBRATION DOCUMENTATION FORM

PROJECT NUMBER:______________

DATE	TIME	WATER LEVEL INDICATOR TYPE	WATER LEVEL INDICATOR NUMBER	CALIBRATION METHOD	CALIBRATED BY (INITIALS)	REMARKS

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TABLE SOP-9

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LOW-FLOW GROUNDWATER SAMPLE FORM

DATE: ____________________ **TASK: ____________________** **WELL ID: ____________________**

SELECT TUBING SPECS	
TUBING DIAMETER	TUBING CAPACITY
3/8" X 1/2"	22 mL/ft
1/4" X 3/8"	9.7 mL/ft
0.17"ID	4.5 mL/ft

Calculate System Volume

Length of tubing: _______ ft x Capacity of Tubing: _______ mL/ft

Tubing Volume = _______ L

+ Vol of flow-thru cell:_______ L

+ Vol of pump:_______ L

Total Vol of System = _______ L x 2 = **Min. Purge Volume =** _______ L

Initial Measurements

Static Depth to water: ____________ ft brp

Well Total Depth: ____________ ft brp

Screened Interval : _____ to _____ ft brp

Pump Intake : ____________ ft brp

brp description (circle one): TOC LS other

Purge Summary Initials: _______________

Begin Purge: ________ End Purge: __________

Tot. Vol Purged: ________L SVs purged: _________

Weather Conditions Time: ___________

Temp. ________°F Skies _______________

Wind ________ mph From______________

Pump Type (circle one) : Bladder pump or Peristaltic Pump

Time	Flow Controller Settings	Depth to Water (ft brp)	Flow Rate (mL/min)	Volume Purged (L)	System Volumes Purged	....FIELD PARAMETERS.... Temp. (°___) +/- 3%	Ph units +/- 0.1 unit	EC (___S/cm) +/- 3%	O.R.P. (mV) +/- 10 mV	D.O. (mg/L) +/- 0.3mg/L	Turbidity (NTU) +/- 10% (if > 10NTU)	COMMENTS

SAMPLE COLLECTION SAMPLE TIME ____________________

ANAYSIS	QUANTITY	TYPE
VOCs by EPA 8260B		40 mL VOA w/ HCl
1,4-Dioxane by EPA 8260B MOD		40 mL VOA w/ HCl

DUPLICATES / BLANKS? Y N

If yes, complete appropriate forms.

AIR MONITORING PID/FID ppm: VAULT __________BKGD___BREATHING ZONE___DISCHARGE WATER____________

NOTES (Color, odor, sand and silt content, factors possibly affecting samples, condition of vault, wellhead, sampling apparatus, etc.)

____

____

____

____

Acronyms and Abbreciations: SVs = System Volumes; brp = below reference point; mL = milliliters; gal = gallons; L = liters; DTW = depth to water; TD = total depth

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PROJECT ____________

TABLE SOP-10

INSTRUMENT CALIBRATION LOG FOR GROUNDWATER SAMPLING: EC METER

DATE	TIME	EC SOLUTION ( )	TEMPERATURE OF SOLUTION	EC READING ( )	CORRECTION FACTOR	METER TYPE	COMMENTS	INITIALS

EC = Electrical conductivity

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PROJECT ____________

TABLE SOP-11

INSTRUMENT CALIBRATION LOG FOR GROUNDWATER SAMPLING: pH METER

DATE	TIME	pH BUFFER (units)	TEMPERATURE OF BUFFER	pH READING (units)	CORRECTION FACTOR	METER TYPE	COMMENTS	INITIALS

HARGIS + ASSOCIATES, INC.

PROJECT ___________

TABLE SOP-12

INSTRUMENT CALIBRATION LOG FOR GROUNDWATER SAMPLING: DISSOLVED OXYGEN METER CALIBRATION (AIR METHOD)

DATE	TIME	METER MODEL	TEMP (ºC)	ELEVATION (ft msl)	SOLUBILITY OF OXYGEN	ALTITUDE CORRECTION FACTOR	CALIBRATION VALUE[(a)] (mg/l)	COMMENTS	INITIALS

(a) Calibration value determined by multiplying solubility value by altitude correction factor

°C = Degrees Celsius
ft msl = Feet mean sea level
mg/l = Milligrams per liter

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TABLE SOP-13

BLANK SAMPLE LOG FORM

PROJECT NUMBER:________________________

MONTH/YEAR:________________________

PAGE _______OF________

DATE	TYPE BLANK (Trip or Rinsate)	SAMPLE IDENTIFIER	TIME	PREPARATION LOCATION	ANALYTICAL METHOD	BLANK WATER SOURCE & DATE	BATCH NUMBER	COMMENTS AND SAMPLING CONDITIONS	INITIALS

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TABLE SOP-14

DUPLICATE/SPLIT SAMPLE LOG FORM

SAMPLE DATE	SAMPLE TIME ACTUAL/REPORTED	SAMPLE LOCATION	SAMPLE IDENTIFIER	ANLAYTICAL METHOD	COMMENTS	INITIALS

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ATTACHMENT C-1 FIGURES

HARGIS + ASSOCIATES, INC.

FIGURE SOP-1
SAMPLE IDENTIFICATION LABEL

HARGIS + ASSOCIATES, INC. Phone: 858.455.6500
9171 Towne Centre Drive, Suite 375, San Diego, CA 92122

Client	H+A Project No.	Initials
Omega	**1217.___**	
Sample ID	Date	Time
	/ /	

Analyze for:

Preservative/Special Instructions:

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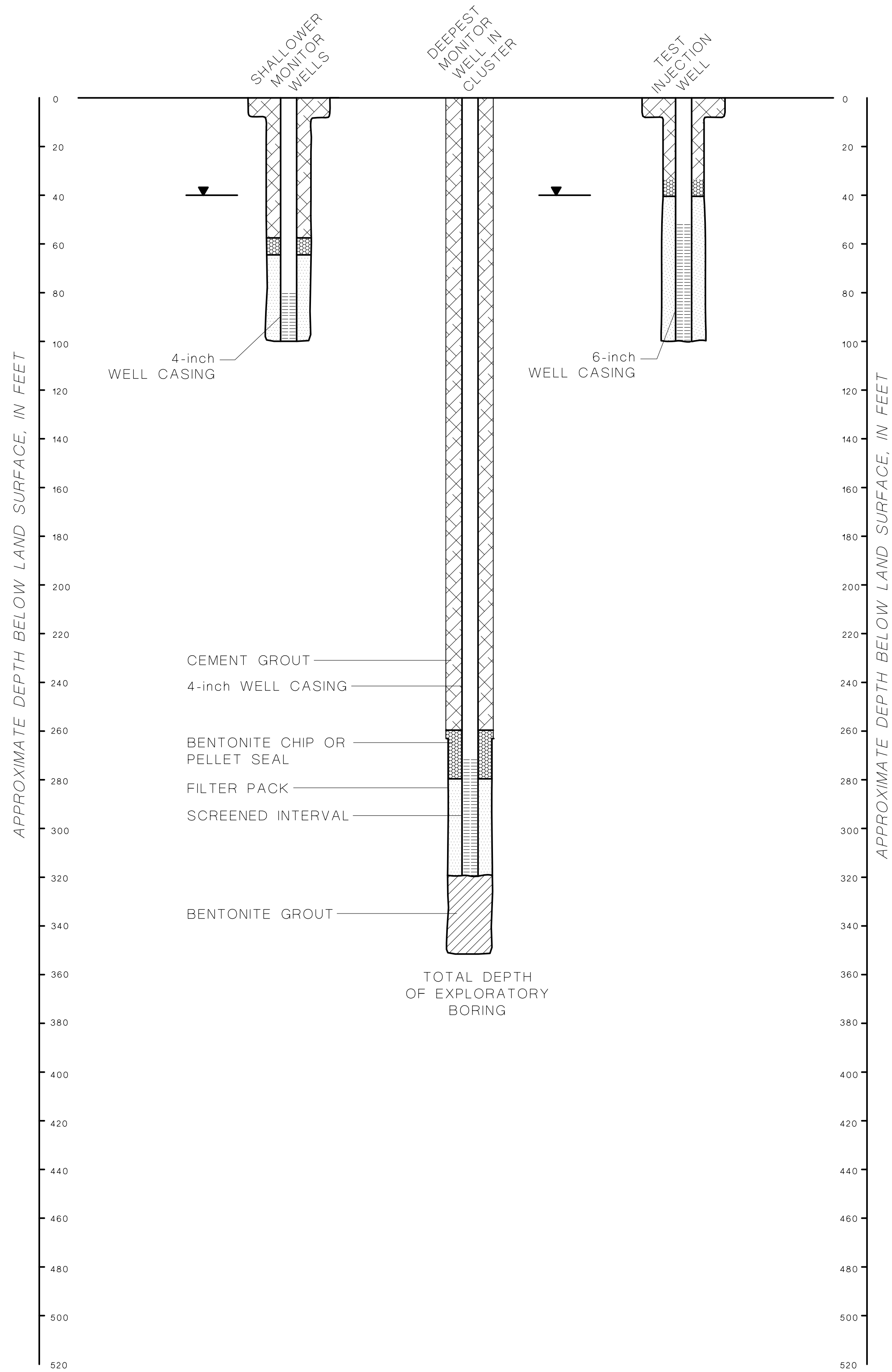

NOTE: ACTUAL DEPTHS TO BE DETERMINED

Jul 26, 2016 – 1:43pm ess – T:\2016\1000-1099\1098 Omega\Hydrogeology\Well Diagrams\710-0896.dwg

7/16	RPT NO. 1098.105	710-0896	A

HARGIS + ASSOCIATES, INC.
Hydrogeology/Engineering

FIGURE SOP-2

SCHEMATIC WELL CONSTRUCTION DIAGRAM